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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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NOTES AND COMMENTS.

The Institution of British Foundrymen's Conference at Blackpool.

The success of a conference is usually judged from the dual standpoint of technical interest and social atmosphere. If this be applied to the Blackpool conference of the Institution of British Foundrymen no other verdict could possibly be returned but that of an unqualified success. To the new President, Mr. Oliver Stubbs, we offer our hearty congratulations, and trust his tenure of office will see a revival in the foundry trade, the interests of which he has so much at heart.

Though only two papers were presented, they contained so much of basic interest to the foundry, as the discussion and written contributions show, coming as they do from such widely separated places as Paris and the United States.

It may be too much to hope that such questions as the benefit or detriment of oxygen and moderate amounts of sulphur in cast-iron will be settled as a result of the Conference, but if they create an interest in the foundries throughout the world much good cannot fail to result.

In one communication the effect of mass in retarding the complete elimination of impurities was emphasised. This coincides with our own experience when manufacturing steel containing 10 to 12 per cent. of silicon, which steel is extremely difficult to "kill," and requires the addition of ferro-titanium or, say, 0.20 per cent. of silicon as ferro-silicon, to be added to the ladle to degasify the metal.

Until the great metallurgical leaders can assure us that reliable methods are available for the determination of the various gases which can be present in ferrous alloys, it is bordering on the dangerous to theorise around them. Who is to say that oxygen in one form of combination might be good and in another, bad? This complicated question seems more difficult if the statement of one eminent member of the Institution is to be taken as correct, this statement being that no two laboratories attached to iron foundries can be relied upon to turn out an ordinary complete analysis with confirmatory results from the same sample of cast iron. We will return to this subject next week, as it is so basically important.

The exchange of Papers with the American Foundrymen's Association has already demonstrated its utility, and the written contributions which have been received are more than ordinarily interesting.

The co-relation of the two Papers was unique, as Mr. Elliott put forward the electric furnace for the improvement of the quality of cast-iron, whilst one of Mr. Shaw's purposes was to ascertain definitely whether the defects which the electric furnace is credited with eliminating are really defects. So intimately associated were these two Papers that the discussion on the one can immediately be applied to the other. Both these gentlemen deserve not only the thanks of the Institution, but of the foundry trade generally.

We were attracted by Mr. Riddell's hypothesis on the concentration of heat in the melting zone of the cupola by the watering of coke to prevent its ignition until it has travelled further down the cupola than would otherwise be the case. Surely this excellent elementary technical notion is capable of scientific development.

The Institution is congratulated on the healthy state of its finances, and the only feature not pleasing about the Annual Report is the closing down of the Peterborough Branch. Whilst no remarks are made, we consider that a *post-mortem* would be interesting, as it might have disclosed pitfalls which the less flourishing Branches could seek to avoid.

The roll of membership is deceptive unless viewed with reference to increased subscription fees and the industrial crisis. Should these two factors be taken into consideration a truly remarkable progress has been shown during the past year.

To the President and Council, to the Mayor and Corporation of Blackpool, and to the directors of Messrs. Vickers, Ltd., we offer our congratulations as being the chief contributory causes of the success of the Blackpool Conference.

Tapping-Hole Shield.—A tapping-hole shield, consisting of a steel plate with a fringe of chains, has been developed by Mr. C. L. Kinney, of the Illinois Steel Company, South Chicago (U.S.A.), for use on open-hearth furnaces, blast furnaces, and at the capping and uncapping platforms in Bessemer plants. The Company has found such a shield effective for preventing burns from molten metal.

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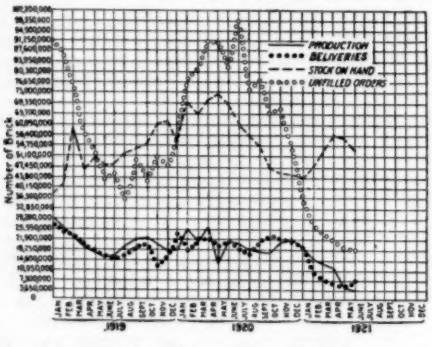
American Refractory Industry.

The Refractories Manufacturers' Association, which embraces almost all of the American manufacturers of fireclay bricks and other refractories in the States, have decided to make public such production statistics as have hitherto been compiled exclusively for private circulation. The accompanying chart, giving the production, deliveries, stock on hand and the unfilled orders of fireclay and silica bricks from January 1, 1919, to May 31, 1921, inclusive, was made up under the direction of the Refractories Manufacturers' Association, but the figures are those for the entire industry and are not confined merely to the reports of Associated members.

The curves reflect conditions within the iron and steel industry, since more than 90 per cent.



PRODUCTION, DELIVERIES, STOCKS, AND UNFILLED ORDERS OF SILICA BRICKS IN U.S., 1919-21.

of the production of fireclay and silica bricks goes to the latter industry. Like the iron and steel industry, the peak of unfilled orders in fireclay and silica bricks was reached in the summer of 1920. At the end of May, 1920, the unfilled orders for fireclay bricks amounted to about 360,000,000, compared with 240,000,000 in November, 1919. The curve of unfilled orders, starting with June, 1920, has been uninterruptedly downward, being almost perpendicular during the latter part of last year, when cancellations were in keeping with business in iron and steel. Unfilled orders at the end of May were about 45,000,000, as compared with 360,000,000 a year ago, a decline in a year of 315,000,000, or 700 per cent.—"Iron Age."

Personal.

THE LATE MR. G. KYTE, Cardiff, retired engineer and iron founder, formerly of the Atlas Engineering Works, Canton, left £900.

THE LATE MR. A. FINDLAY, managing director of Alexander Findlay & Company, Limited, left personal estate in the United Kingdom valued at £30,379.

MR. A. SHEPHERD has been appointed chairman and Mr. George Balfour, M.P., vice-chairman of the Lancashire Electric Light and Power Company, Limited.

SIR HERBERT HENRY BARTLETT, BART., chairman and governing director of Perry & Company (Bow), Limited, who died last June, left unsettled property of the gross value of £486,680, with net personalty £476,639.

MR. H. L. CRITCHLEY, late manager of the Scotswood Locomotive Works of Sir W. G. Armstrong, Whitworth & Company, Limited, who has secured another appointment, has been the recipient of handsome presentations from the officials, foremen, and workpeople. Mr. P. A. Hyde has succeeded Mr. Critchley at Scotswood.

COLONEL JAMES SMITH PARK, J.P., a director of William Beardmore & Company, Limited, who died on February 1, aged 66, left, exclusive of real estate, personal estate of the total value of £1,219,908, of which the personal estate in the United Kingdom amounts to £1,081,186.

MR. R. GRANT, JUNIOR, of the firm of Messrs. Higginson & Company, has been elected a director of Richard Thomas & Co., Ltd., in the place of Lord Bledisloe. Mr. Grant is a director of Bell Bros., Limited; the British Mannesmann Tube Company, Limited; Channel Steel Company, Limited; Dorman, Long & Company, Limited; the Itabira Iron Ore Company, Limited; the North-Eastern Steel Company, Limited; the Phœnix Dynamo Manufacturing Company, Limited; and Sir B. Samuelson & Company, Limited.

Weighing Apparatus in the Foundry.

The correct and systematic weighing of foundry materials is of the utmost importance, if good castings are to be produced with economy and despatch. In the modern foundry the bulk material, both iron and coke, is carefully analysed before purchasing, and also periodically analysed at the factory to ensure that the quality is being maintained.

The laboratory apparatus is generally of the best quality, and it is just as important that the various grades of metal should be correctly weighed before being put into the cupola, otherwise the castings will not give the desired analysis. The conditions which obtain vary considerably in different foundries, depending on the layout of the plant, and the nature of the castings to be produced. In most cases it is the practice to have a small stock of material comprising the charges on the cupola platform, although sometimes these stocks are kept on the ground level, the charges being automatically elevated and discharged into the cupola mouth. Probably the most important machine in the whole foundry is that which weighs the various materials comprising the charges. It is, therefore, of the utmost importance that the weighing apparatus at this point should be the best of its kind and the most suitable for the work. The type of machine used here is generally of the dormant pattern, of heavy construction, the platform being of sufficient size to accommodate the wheelbarrows or bogies, the indicating arm being of the no-loose-weight type. To enable continuous records to be kept a tape or ticket-recording device may be fitted.

A special machine has been produced for weighing and recording charge—a type which has been widely adopted for blast-furnace work. It is not so generally used in ordinary foundry practice, although it is eminently suitable for the work. The apparatus consists of a series of, say, six steelyards, three or four steelyards being used for the various grades of pig, one for scrap, one for coke, and sometimes one for limestone. The steelyards are totally enclosed in a lock-up case, the various weights not necessarily being known by the barrowman. The charge hand or other administrative person, sets the poises to the various weights of each grade, etc., required. A small trigger outside the case enables the operator to put into use the steelyard corresponding to the nature of the material which is on the weighing platform. The triggers are either numbered or otherwise suitably inscribed to denote the material, the correct weight, of which has been set by the poise on the steelyard. Individual or cumulative weights may be put on the platform; that is to say, the total constituents comprising the charge may be weighed collectively or individually; of course, each constituent must be on the platform separately. To increase the speed of operation, and ensure accuracy a pointer, which has a plus and minus range is sometimes fitted. This enables the operator to see when the correct load is being approached. Also a recording device may be fitted, which records the exact weight of each charge, whether correct, or in excess or deficiency. This machine is a distinct advance in the weighing of furnace charges, and if properly used and maintained, no doubt ensures reliable castings.

It is not generally desired to weigh the molten metal in the ladles, but machines have been supplied of the suspended pattern, having clock-face dial indicating automatically the weight of the metal as it is poured into the ladle. On these machines special guards have to be fitted to protect the mechanism from the heat of the metal.

The weighing of the finished castings may be taken on either a truck weighbridge or portable or dormant platform machine, the type of machine used depending entirely on the class of work turned out; the truck machine being used for heavier castings, the dormant machine for castings of medium weight, and the portable machine for light castings. These machines should be fitted with no-loose-weight steelyard, or preferably with tape or ticket-recording system steelyards, so that accurate record may be kept of output. A platform or dormant machine should also be provided for weighing the gates, spills, and bad castings. This should be placed near the cupola.

The sand is generally weighed in bulk, but it is sometimes desired to apportion the day's requirements. In this case a dormant machine fitted with rails to suit the bogies may be installed.

MOLYBDENUM BRONZE.—Mr. S. Shigita describes in American Patent No. 1,319,537 a molybdenum bronze which is claimed to possess the colour and general appearance of gold. It may be worked into leaf form, and in many other respects resembles gold. The composition given is copper 80, aluminium 10, molybdenum and tungsten each 5 per cent.

The Shipping, Engineering and Machinery Exhibition.

(*Continued from page* 205.)

ROWLAND TRIST & COMPANY, LIMITED, London, show a complete automatic table outfit, comprising machine-driven table, sand-blast chamber, sand elevator, sand screen, and exhaust installation with sand-dust arrester, driven by Broom & Wade multi-cylinder air compressor through a BT-H motor. The "Guardian," a patent safety device for use with oil-fired boilers: It will automatically and instantaneously cut off the oil supply to the furnaces when the water reaches danger level. "Thermofeed" regulator: To control the water level at its most economical fixed height, resulting in a great saving of fuel. Land and marine types are being shown.

W. & T. AVERY, LIMITED, Birmingham.—Among these exhibits of testing machines are two balancing machines for connecting rods and crank shafts. The latter is a very accurate form of static balance with automatic indicators showing the "out-of-balance" in inch drams. The crank-shaft is instantly placed upon the machine and the readings taken almost immediately, so that there is no loss of time in finding out the amount of error prior to correction. A similar machine is made to this for balancing flywheels, the only difference being that for flywheels, the length of the machine is very materially cut down, and the cradle widened out to take the necessary diameter. Amongst other interesting exhibits that this firm are showing are examples of their 30-ton Universal testing machine, the "Izod" impact tester, and Brinell hardness testing machine, designed on the weighing lever principle. In regard to the latter, a very interesting calibration lever is being shown which is applicable to most Brinell machines. The Brinell test, as is known, employs a definite load of 3,000 kilos., and there should be ample use for this apparatus in verifying the many machines which are in use.

HENRY ROSSELL & COMPANY, LIMITED, Sheffield.—Exhibit includes a very complete range of tools covering a wide field of engineering practice and including all classes of drills, reamers, milling cutters, turning tools, hacksaws and files; also a special exhibit of machine knives, including shear blades of every type, guillotine knives, circular cutters, spiral cropping blades, ledger and Paisley blades, logwood knives, tobacco knives and blades for a variety of general purposes.

THE CAMBRIDGE & PAUL INSTRUMENT COMPANY, LIMITED, London, have at their stand a representative collection of their products as used for ships, including electrical CO_2 instruments, draft and pressure gauges, temperature measuring apparatus, etc. The electrical CO_2 instruments are of particular interest, being entirely new apparatus of this nature. These instruments are purely electrical, requiring no chemical absorbent and no delicate glass work; they are particularly accurate and sensitive. The CO_2 meter itself contains two identical spirals of platinum wire enclosed in two separate cells in a metal block, one cell containing air saturated with water vapour, and the other being open to the flue gases. The platinum spirals form two arms of a Wheatstone bridge circuit. When a current flows in this circuit the two spirals become heated, and lose heat to the walls of the cells, their temperatures, and consequently their resistances, depending on the thermal conductivities of the gases surrounding them. Changes in the percentage of carbon dioxide in the flue gas surrounding the one spiral cause changes in the conductivity of the gas, and a consequent change in the galvanometer deflection. The indicating or recording galvanometer, which is connected to the CO_2 meter, can, therefore, be calibrated to give direct readings in percentage of carbon dioxide The exhibit also includes indicating, recording and combined indicating and recording outfits for one or more points, and also a new portable outfit, which is extremely useful for occasional tests; this instrument gives permanent records of the percentage of CO_2 over a period of 24 hours. A similar recorder is made giving the percentage of CO_2 and also flue gas temperatures on one chart. A number of draught and pressure gauges are also shown. Dial gauges are also shown for indicating draught or pressure up to 6 in. of water. The exhibit also includes a collection of electrical distance thermometers. This thermometer may be used for any range between 200 deg. and 540 deg. C. These electrical distance thermometers are a type of platinum resistance thermometer in which the out-of-balance current in the Wheatstone bridge is allowed to deflect a galvanometer. With the resistance thermometers a portable outfit, consisting of a Whipple indicator and laboratory pattern resistance thermometer, is shown. This forms a very convenient reliable standard outfit by which other temperature-measuring instruments can be checked. This instrument is a form of Wheatstone bridge, especially designed for use with platinum-resistance thermometers. The bridge is balanced by turning a handle, and the instrument is calibrated to give direct readings of temperature. The instrument is entirely self-contained, and since the galvanometer has a pivoted coil levelling is unnecessary. A 12-point thermo-electric pyrometer indicating outfit is shown with totally enclosed indicator in moisture and fume-proof cast-iron case, specially designed for marine work. Several types of indicating and recording instruments are shown, including a simple thermo-electric pyrometer for superheated steam temperatures, and also an outfit for measuring the temperatures of armature windings. The principle upon which the thermo-electric pyrometer depends is as follows:—If two wires of dissimilar metals are joined at their ends to form an electric circuit and one junction is heated, an electromotive force is set up which gives rise to an electric current in the circuit. The magnitude of the electromotive force depends upon the temperatures of the hot and cold junctions. It is consequently possible, by introducing in the circuit a galvanometer by means of which the electromotive force generated can be measured, to determine the temperature of the hot junction, provided the cold junction temperature and the relation between temperature and electromotive force for the two metals used are known. Such a circuit can thus be used for the measurement of temperature, and a thermo-electric pyrometer consists essentially of a thermo-electric circuit in which the hot junction is exposed to the temperature to be measured, and the resulting electromotive force is measured on an indicating or recording milli-voltmeter, which for convenience is usually graduated to read directly in degrees of temperature.

ALLOY WELDING PROCESSES, LIMITED, are showing under working conditions a portable petrol-driven electric arc welding set, absolutely self-contained. In order to meet the demands for a welding set to connect to a D.C. supply up to 600 volts they have specially designed the new "A.W.P." motor generator arc welding plant. This machine will be found particularly suitable for work that has to be carried out in the open as the set is totally enclosed in a sheet metal cover and the instruments and switchgear are fitted on to the ends of the steel enclosure in a perfectly water-tight manner. For connection to alternating current supply an entirely new type of welding plant is on view, the special advantage of which is that the voltage used is only 50, thus eliminating the danger from shock. Another advantage of this machine is its high efficiency combined with light weight, namely, 3½ cwt. complete.

THE CARRON COMPANY, Falkirk, exhibit their wood-working machinery. The "Carronette" machine shown is for hand mortising only, while that of the "Carronade" is for mortising and boring, and is fitted with a special vice for wheel naves. They also show motor-car flywheels in cast iron, etc.

LACY HULBERT & COMPANY (1921), LIMITED, Beddington, Surrey.—A comprehensive exhibit includes a portable petrol-driven air compressing plant, capacity 35 cub. ft. of air per minute to 100 lbs. per sq. in.; seven vertical air compressors, made in a range of sizes for pressures up to 250 lbs. per sq. in., and for h.p.s ranging from

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½ h.p. to 100 h.p.; patent horizontal air compressors; vacuum pumps; patent rotary blowers or exhausters of positive type; a portable electric air blast machine; rotary pumps of various types for pumping crude oil, petrol, water and other liquids; hand air compressors, hose, connections, blowing nozzles, cocks, tools, valves, etc.

ALLEN-LIVERSEDGE, LIMITED, London, are giving demonstrations of acetylene welding and cutting apparatus. An interesting feature of this exhibit is a specially-designed burner for brazing by acetylene. The burner is on the Bunsen principle, and as the necessary pressure is furnished from the acteylene cylinders and no separate air supply is required the plant is self-contained and portable.

CARBIC, LIMITED, London, show acetylene lighting, cutting and welding apparatus, and are giving practical demonstrations of the various applications.

THORN & HODDLE ACETYLENE COMPANY, LIMITED, London, include in an interesting exhibit of oxy-acetylene apparatus, low-pressure generators, and a portable welding and cutting plant, the whole of the apparatus being mounted on a wheel base. They also show fixed delivery types of blowpipes, interchangeable nozzle blow pipes, etc.

DAVIS BOURNVILLE COMPANY, Jersey City, U.S.A.—This exhibit marks an entirely new era, as far as this country is concerned, in the application of oxy-acetylene to cutting operations. The apparatus is mechanically controlled, and will cut steel with remarkably good finish, up to a thickness of 20 in. For trimming and bevelling boiler sheets to the correct flange height and caulking angle in one operation the functions of the apparatus are unique.

THE DELTA METAL COMPANY, LIMITED, Greenock and Birmingham, have a very tastefully-arranged exhibit, demonstrating the scope of their manufactures, not the least interesting of which are the forgings in Delta bronze, which range from a few ounces in weight up to 45 cwts. This last has a tensile strength of 34 tons, with elongation of 28 per cent.

THE YORKSHIRE COPPER WORKS, LIMITED, Leeds, amongst a very beautiful range of copper tubes, make a special exhibit of Bemal brass condenser tubes, which consists of specimens used in an exhaustive test of Bemal and other condenser tubes tested side by side under severe corrosive conditions. These specimens, in conjunction with the details of the test, are worth careful inspection.

PERKIN & COMPANY, LIMITED, Leeds, include in an exhibit of machine tools, electric welders, seam, butt and spot, which are shown in operation.

THE SHEEPBRIDGE COAL & IRON COMPANY, LIMITED, Sheepbridge.—The exhibit covers practically a complete range of the company's productions from coal briquettes, pig-iron, to castings and finished machines. An interesting feature of the exhibit are the centrifugal castings, which include: Diesel engine liner, turbine gland casting, piston pot castings, etc.

H. C. SLINGSBY, London, exhibits a range of trucks covering about 60 types, which include the sliding wheel truck, jack lift master truck, and electric elevating platform trucks, etc.

JOHN THOMPSON (WOLVERHAMPTON), LIMITED, Wolverhampton, show a complete Kennicott type "K" water-softening plant. Samples of boiler parts and sectional tube superheater, corrugated flue section, self-supporting steel chimney, pressed steel weldless annealing pot, etc.

MAJOR ROBINSON & COMPANY, LIMITED, Manchester, show pipe-bending machines, and include on their stand samples of cements for iron and steel, jointing compound, etc.

ELECTRO-MECHANICAL BRAKE COMPANY, LIMITED, West Bromwich, exhibit a collection of unbreakable jointless and rustless grid resistances, steel-case controllers containing many new features, etc.

THE MILLWALL ENGINEERING COMPANY, LIMITED, London.—This exhibit comprises some beautiful examples of tube bending and coil work, together with all classes of steam fittings.

E. BROOK, LIMITED, Huddersfield, show a range of five types of motors, protected, enclosed, pipe-ventilated, drip proof and slip-ring, also the stator of 100 h.p. motor, with windings, motors fitted with reduction gears, motors attached to blowers, etc.

THE GALVANISING EQUIPMENT COMPANY, LIMITED, London, show a complete unit for their rust-proofing process, as also a number of articles demonstrating the utility of the process.

THE HOYT METAL COMPANY OF GREAT BRITAIN, LIMITED, London, show a complete range of their well-known anti-friction metals. Diesel engine and other bearings are exhibited, as also a selection of die-casting bearings and bushes.

T. H. PICKLES & SONS, Halifax, exhibit standard samples of plain and ornamental castings.

HANCOCK & COMPANY (ENGINEERS), LIMITED, Surrey, show complete plant for welding with coal gas and oxygen, also cutting plants, and the Hancock electric furnace, suitable for tool-room service, and in which a temperature of 2,500 deg. C. can be obtained when required.

EMPIRE RUNWAYS, LIMITED, London. — The characteristic feature of this exhibit is the steel tubular track known as the Coburn system, within which the trolleys run, the whole being self-contained.

THE CLUPET PISTON RING & ENGINEERING COMPANY, West Hampstead, N.W., show examples of double coil no gap piston rings, for which they claim absolutely uniform expansion.

C. H. ROBINSON, London, exhibit the Chapman hanger ball bearings.

J. J. ALLEN & COMPANY, Durham, show a number of special apparatus and tools, which include die plate valve and valve seats refacing device, boiler tube and pipe cleaning devices, coal levelling and loading machine, etc.

THE PATENT DIE CASTINGS COMPANY, LIMITED, Willesden Green, N.W., have an exhibit of die-castings, beautifully clean and well worth inspection.

T. B. BILTON & SONS, LIMITED, North Shields, show a copper-pipe bending press, complete with set of three-throw hydraulic pumps, motor-driven. Various fittings in connection with piping installations, etc.

EDISON ACCUMULATORS, LIMITED, London.—Exhibit consists of a number of Edison accumulators ranging in capacity from 1.5 to 450 ampere hours, and varying in application from wireless "valve circuits" to the propulsion of 5-ton electric vehicles.

GEO. SALTER & COMPANY, LIMITED, West Bromwich, show a crane weighing machine, cement testing machine, dynamometers, tension ratchets, pressure gauges, etc.

THE LONDON ELECTRIC WIRE COMPANY & SMITHS, LIMITED, London, exhibit a large selection of their specialities, which include silk and cotton insulated wire, enamel insulated for armature, magnet and coil winding, and in high resistance alloys for electric starting and heating purposes, etc.

THE CONSOLIDATED TOOL COMPANY, LIMITED, London, show a range of their well-known tools.

THE CONSOLIDATED PNEUMATIC TOOL COMPANY, LIMITED, London, show electric lifting blocks, electric drills, and small grinders, and include on their stand a full range of pneumatic tools for riveting, caulking, chipping, etc.

BUCKLEY, SAUNDERS & COMPANY, LIMITED, London, show the "Cyc-Arc" welding plant, with which they are giving practical demonstrations. The exhibit also includes a range of machines for resistance welding.

THE GENERAL FOUNDRY & ENGINEERING COMPANY, LIMITED, Lutterworth, show their improved hand-operated moulding machines, of which a fully illustrated description appeared in our issue, dated August 18.

BRUNTON & TRIER, London.—The feature of this exhibit is the "Multiplex" grinder—a bench type of machine with removable head, for use as an external or internal grinding attachment on lathe or other suitable machine tool, a new simple twist drill grinding attachment in which all adjustments for varying sizes of drills are automatically made, tool rest and table adjustable to any position, etc. Other exhibits comprise emery wheel dressers, etc.

W. KENNEDY, West Drayton, is showing a range of "Kennedy" patent bending machines.

NEGRETTI & ZAMBRA, London.—Temperature indicators and recorders, recording water gauge for flue gas pressures, etc.

BRITISH ARC WELDING COMPANY, LIMITED, London, exhibit comprises some interesting specimens of work carried out.

Institution of British Foundrymen.

Annual Conference at Blackpool.

Civic Welcome.

The eighteenth annual meeting and conference of the Institution was held in the Municipal Lecture Hall, Queen Street, Blackpool, on Wednesday and Thursday, September 14 and 15. The Mayor of Blackpool, Alderman C. W. Callis, J.P., accompanied by Alderman Heap (Chairman of the Finance Committee), attended to welcome the members. He remarked that of all the bodies who had been welcomed to the town the Institution of British Foundrymen was about the most important. As a man who had to gain his knowledge of the industry from newspapers, he could quite understand that at the present time they faced difficulties and dangers in every possible shape and form. Not only had they to provide against the unrest which was rampant in the country, they had also to provide against foreign competition on the part of Germany and America; and he hoped their deliberations would lead them to conclusions which would once again put the great iron industry of England in the forefront. There was a time when they were unsurpassed, when nobody could touch them, and he hoped that time would come again. It was one of the key industries of this country, and it was for the members of the Institution to support the nation, and he was sure they would do so to the best of their ability.

ALDERMAN HEAP said he had attended many conferences in his time, and he was impressed by the number of young men who were present that day. He hoped their deliberations would lead them into paths where they would find full compensation for their efforts. When he was a youth he passed a foundry every morning and every night, and, knowing the nature of the work, it used to amaze him that men could be got to carry on the industry. No doubt that had something to do with some of the present difficulties, and as one who looked upon the industry from the outside, trying to understand what was necessary, he urged that the best solution of their difficulties was for employers and workmen to work together amicably. The workpeople could not do without capital, and it was equally certain that the employer could not do without workpeople, and the furtherance of the interests of both, and also the progress of the country depended upon collaboration and co-operation between them.

THE PRESIDENT (Mr. Riddell) said he agreed that the foundry industry was a most important one, and upon it other industries were dependent; indeed, there was evidence in Blackpool itself how it had played its part in building up the town. They were trying to solve great problems, and were already putting into practice Alderman Heap's suggestion of co-operation and collaboration. That was one of the purposes of the Institution. All classes of men engaged in the industry were eligible for membership, and they all worked together for its advancement.

MR. OLIVER STUBBS,

President of the Institution of British Foundrymen.

Mr. Stubbs is joint managing-director of Messrs. Joseph Stubbs, Limited, Mill Street Works, Ancoats, Manchester, one of the best known of textile engineers and ironfounders in the North of England. Their product ranges from a few ounces up to 10 tons. Mr. Stubbs has been the President of the National Ironfounders Employers' Federation since its inception six years ago.

Message of Sympathy.

The minutes of the last annual meeting and conference having been read and passed, the PRESIDENT (Mr. Riddell) said Mr. W. Mayer (Dumbarton) had looked forward to being present at the conference, but at the moment was seriously ill. The members might authorise the Council to send a message of sympathy and an expression of regret that Mr. Mayer was not present.

The suggestion was agreed to unanimously.

Election of President.

THE PRESIDENT said his term of office which was about to expire had been a year of strenuous work, but it was also a year of enjoyment. The Council had worked with enthusiasm; the meetings were more numerous than in former years, and they had been well attended. He did not think there were ever less than 20 members present. When there was a Council of active workers like that there was very little for the President to do, and he wanted the members to give the credit for the success of their labours to the Council. No person did harder or more loyal work than Mr. Oliver Stubbs. They knew a great many of his merits, though not all, and he was certainly qualified in every way to fill the office of President during the next year. The welfare of the Institution would be in safe hands.

MR. T. H. FIRTH (Sheffield) said he had met Mr. Stubbs on all kinds of committees during many years. He nearly always turned up and when he did the others knew it, because he always had something to say. The Institution could not have a better President. He therefore seconded the motion that Mr. Oliver Stubbs be elected President for the coming year.

The resolution was carried unanimously. Mr. Riddell then invested Mr. Stubbs with the chain of office and vacated the chair, which was occupied by Mr. Stubbs.

THE PRESIDENT, who was heartily welcomed, said he was fully aware of the work that had to be done, and, in the course of his presidential address he would put before the members his views upon certain questions, but at this moment he would not go further than thank the members for the great honour they had conferred on him, and express a hope that when it came to his turn to lay down the office of President he would leave the Institution in as good order as it was in when he took the presidential chair.

Report and Balance Sheet.

The report of the Council and the balance-sheet which are presented herewith, were taken as read.

The General Council have pleasure in presenting to the members the following Report of the progress and work of the Institution during the past Session, 1920-1921.

Eight General Council Meetings have been held during the Session at Glasgow, York, Birmingham, Manchester, Peterborough, Leeds, Blackpool, and Manchester respectively, members attending from

all parts of the country and representing all the Branches. There has been an average attendance at the General Council Meetings of 22.

The respective Branches have the following members attached:—

	Members.	Associate Members.	Associates.	Total.
Birmingham ...	50 (57)	99 (105)	35 (39)	184 (200)
Coventry ...	33 (31)	92 (130)	34 (93)	159 (254)
East Midlands...	35 (25)	89 (44)	18 (9)	142 (78)
Lancashire ...	84 (80)	148 (126)	7 (6)	239 (212)
London	75 (73)	54 (50)	6 (7)	135 (130)
Newcastle-on-Tyne	77 (60)	92 (74)	36 (34)	205 (268)
Scottish	68 (56)	160 (140)	73 (78)	301 (274)
Sheffield	82 (84)	104 (93)	13 (7)	199 (184)
Peterborough now merged in East Midlands	— (11)	— (30)	— (11)	— (52)
General	30 (35)	26 (16)	—	56 (51)
Totals ...	534(511)	868 (808)	222(284)	1620(1603)

The figures in brackets are those for the Session 1919-1920.

In addition to the figures given above there are 11 members, 29 Associate members, and 3 Associates whose election has been confirmed but whose subscriptions have not yet been paid. Excluding the latter the total number of members on the roll of the Institution on July 30, 1921, was 1,620, showing an increase for the Session of 17. Six deaths have been recorded. Thirty-three members, 154 Associate members and 123 Associates have resigned or ceased to become members through removals or through their subscriptions having been allowed to lapse.

It will be borne in mind that our subscriptions have been raised as from January 1, 1921, and this, and the severe depression in trade and loss of work in some parts of the country, is responsible for the small increase in membership. Your Council foresaw that the advance in subscriptions would mean a number of resignations, but the increased cost of maintenance of the Institution in every direction made the increase absolutely necessary if we were to continue, and the General Council have no doubt that the falling off in membership will soon be overcome and the Institution be in a more flourishing and useful condition. The General Council ask for the co-operation of the members in securing new members and feel that the present number could easily be doubled by a little personal effort and interest on the part of the existing members.

The members of the General Council who are retiring in accordance with the Rules are Messrs. W. H. Cook, B. Hird, T. W. Markland, H. Pemberton and J. G. Robinson.

ROYAL CHARTER.—Your Council much regret that this is not yet granted. The petition, after amendment, was lodged by our solicitors on February 16 last with H.M. Privy Council, and we still await their decision.

NEW RULES.—These have now been issued, a sufficient number having been sent to the Branch Secretaries to entitle every member to have one free copy.

SUBSCRIBING FIRMS.—The members who attended the Glasgow Conference will remember the suggestion and discussion of the question of endeavouring to obtain firms interested in foundry work to become subscribers of five guineas per annum.

Your Council are pleased to state that since this was first mentioned five firms in the Newcastle district and two in the Coventry district have become subscribers, and think that with a little effort on the part of members, especially Branch officers, a large number will comply with this and so help forward the work of the Institution.

The formation of a Branch at Bradford has not yet been accomplished, but the Council have this well in mind.

PRINTED LIST OF MEMBERS.—This is included in the bound volume of Proceedings, 1919-1920, recently issued.

BRITISH CAST IRON RESEARCH ASSOCIATION.—The Council are very gratified in being able to report that the steps taken in 1919 by this Institution to formulate a Research Association for the cast iron industry have resulted in the British Cast Iron Research Association being formed and incorporated. On the Council of the Association five members of the Institution Council have been elected, viz., Messrs. F. J. Cook and M. Riddell (Vice-Chairmen of Council), J. Cameron, R. O. Patterson, and O. Stubbs. The Institution is also officially represented by Mr. H. L. Reason and Mr. E. H. Broughall. The Council believe that the work of the Research Association will ultimately have far-reaching effects upon the work of the Institution and the industry generally, and will carry out those ideals which the Institution has in the past advocated. The Council consider that it is a very proud achievement to have been the means of starting this great research work for the industry.

PRESIDENTIAL CHAIN OF OFFICE.—The donor of the chain, Mr. W. Mayer (Past President) has been graciously pleased to have eight additional links added to it. Mr. Mayer has also kindly promised to present gold medals in perpetuity to the Scottish and Newcastle Branches for competitions.

The accounts and balance-sheet of the Institution are presented herewith:—

INCOME AND EXPENDITURE ACCOUNT

From January 1 to December 31, 1920.

EXPENDITURE.

	£ s. d.	£ s. d.
Postages		71 14 4
Printing and stationery, including printing of Proceedings		412 15 8½
Council, Finance and Annual Meeting expenses		42 6 5½
Branch expenses, viz.:—		
Lancashire	27 17 8	
Birmingham	55 4 2	
Scottish	51 1 5	
Sheffield	45 5 2	
London	54 15 10	
East Midlands	15 12 10	
Peterborough	3 14 3	
Newcastle	52 2 8	
Coventry	60 19 11	
		371 13 11
Proceeds of sale of autograph menu card to Princess Louise Scottish Hospital ...		14 1 9
Illuminated addresses		13 13 0
Audit fee		6 6 0
Incidental expenses		11 11 5
Salaries, Secretary and Clerk...		241 17 10
Rent of Office		50 0 0
Bank charges and interest		4 9 5
Depreciation furniture, &c.		9 2 1
		£1,249 12 11

INCOME.

	£ s d.
Subscriptions received	1059 17 1
Sale of books, etc.	12 3 7
Interest on War Loan	22 10 0
Bank Interest	0 14 11
Rent received, Heating and Ventilating Engineers (6 months)	12 10 0
Sale of autograph menu card, Loch Lomond steamer	14 1 9
Balance, being excess of expenditure over income ...	119 15 7
	£1,249 12 11

BALANCE SHEET.

December 31, 1920.

LIABILITIES.

	£ s. d.	£ s. d.
Subscriptions paid in advance		60 10 6
Sundry creditors		265 6 0
Royal Charter Fund—		
Amount subscribed	402 16 0	
Less expenses	151 11 8	
		251 4 4
Surplus as at 31st December, 1919 ...	375 9 11	
Less excess of expenditure over income for year ended 31st Dec., 1920	119 15 7	
		255 14 4
		£823 15 2

ASSETS.

	£ s. d.	£ s. d.
Cash in hands of Secretaries, viz.:—		
Birmingham	6 16 11	
Lancashire	8 11 4	
London	1 0 11	
Scottish...	28 9 2	
East Midlands	10 14 6	
Sheffield	8 3 9	
Peterborough	2 14 6	
Coventry	4 19 1	
Treasurer	2 10 0	
General Secretary, Petty Cash ...	1 1 8	
	75 11 10	
Less due to Newcastle Sec.	28 19 10	
		46 12 0
London City and Midland Bank, Limited	11 9 7	
Ditto Royal Charter Account... ...	251 4 4	
		262 13 11
Furniture, fixtures and fittings	70 5 0	
Add additions	20 16 3	
	91 1 3	
Less Depreciation 10%	9 2 1	
		81 19 2
Investment Account—		
War Loan at cost		432 10 1
		£823 15 2

W. G. HOLLINWORTH,
Gen. Secretary.

F. W. FINCH,
Hon. Treasurer.

We have examined the above balance sheet with the books and vouchers of the Institution, and find same to be in accordance therewith.

FRANK CREKE, HARCOURT & CO.,
Auditors,
23, Colmore Row, Birmingham.

April 15, 1921.

MR. W. H. COOK (Lancashire) complained that the balance sheet did not accurately represent the position of the Institution, certain items of expenditure having been charged which had not yet become due, and ought to have come into the accounts of a later year.

MR. T. VICKERS (Birmingham) moved the adoption of the report and balance sheet. He observed that it was impossible to avoid an adverse balance under the conditions which had prevailed. The membership ought to be increased.

MR. J. CAMERON (Scottish) seconded. He thought the Institution was to be congratulated upon the balance sheet. Every item had been subjected to strict scrutiny, and the point raised by Mr. Cook was really a technical one.

The resolution having been passed unanimously, the PRESIDENT pointed out that the balance sheet brought the account down to December 31, 1920, and in the interval the financial position of the Institution had improved, there being now in the bank £531.

Presentation to Mr. Little.

THE PRESIDENT said his first duty was, indeed, a pleasure. It was to ask Mr. Riddell to present to Mr. Little an illuminated address in album form. Mr. Little was President prior to Mr. Riddell.

MR. RIDDELL said this duty was a very pleasant one. He followed in the footsteps of Mr. Little, and was very much helped by the experience which he acquired in association with him. The members knew the interest that Mr. Little took in the Institution and the thoroughly good work that he did for it during a very trying and difficult time. They owed more to him than most of them realised. The address stated that it placed on record the members' appreciation of the services rendered by Mr. Little as President in the year 1919-20. Under his presidency the Institution continued to grow in numbers and influence, and to this his enthusiasm and self-sacrificing work largely contributed. He had consistently upheld a high standard of education so that the industry might be more fitted to retain and increase its national importance.

MR. LITTLE, replying, said it gave him great pleasure to receive this recognition of his efforts. He took up his duties with the intention of doing his best, and he did it. Only those who had held office knew the difficulties that were dealt with. In a way they were called upon to change boats when going down a stream, which was not always a wise proceeding, but things had come out very well indeed. He did not claim personal credit for that, it was entirely due to the support he received. The excellent work done in those twelve months was continued under the management and guardianship of Mr. Riddell, and it would develop and mature under Mr. Stubbs. As time went on, some of those now in the body of the hall would find their way to the platform, and in their turn they would realise the work that had to be done to bring the Institution to its present state of efficiency. A good foundation had been laid, and the members could now bring the Institution into the front rank. The younger men were coming along, and he had no fear that they would not do their share as the others had done who went before

Other Elections.

The PRESIDENT proposed that Mr. H. L. Reason (Birmingham) be elected senior vice-president.

MR. LITTLE, in seconding the resolution, remarked that he had been associated with Mr. Reason for a number of years in Council work and had always found him a very live man, prepared to take up any duty that required very special attention, and make a success of it. He was a man who would make himself felt; they would hear a lot of him in the future.

The resolution was carried unanimously. In replying, MR. REASON promised to do his utmost to uphold the traditions of the Institution.

MR. V. C. FAULKNER (London) moved the election of Mr. J. Jewson (East Dereham) as junior vice-president. He said it was some twelve years since he first knew Mr. Jewson, who at that time appeared to him to be a stalwart of the Institution. He had been a stalwart ever since.

MR. H. FIELD (Birmingham) said those who had been working on the Council knew what Mr. Jewson had done, and they could unhesitatingly recommend him to the members. He seconded the motion with very much pleasure.

The resolution was carried unanimously.

MR. JEWSON said his home was situated in the Eastern Counties, and he was not quite so much in touch with the other members of the Institution as he would like to be, but he had reaped enormous benefit from his association with it, and hoped to do something in repayment. He had its welfare at heart. He had received such great help from the members of the Council that he had been able to accept the post, and he did so with a grateful heart. He hoped they had many years of prosperity before them.

MR. J. ELLIS (London) proposed the reappointment of Mr. F. W. Finch as treasurer. This was seconded by MR. CARRICK and carried unanimously.

Council Vacancies.

The PRESIDENT said there were only six vacancies to fill. Mr. Aitken was not now a member of the Institution. Messrs. W. H. Cook, B. Hird, T. W. Markland, H. Pemberton, J. G. Robinson and Mr. J. Cameron (Scottish) were elected by ballot.

Presidential Address.

THE PRESIDENT (Mr. Oliver Stubbs) delivered the following address:—

GENTLEMEN,—It was not without due consideration and much thought that I allowed my name to go forward for election as Junior Vice-President of the Institution of British Foundrymen. All my working life has been spent practically associated with foundry work, and at the time of my nomination and election I felt, in common with other members of this Institution, that due prominence was not being given to our work. It was with this feeling in mind that I accepted office with the sincere hope that my efforts, small as they might be, would be directed towards uplifting the industry in its relation to the general engineering and allied trades. Whatever share of work was allotted to me, I was prepared to undertake, to the best of my ability, and it is, therefore, with extreme pleasure that to-day, when I occupy the Presidential chair, it can be said that we have materially raised our status, and I hope that during my year of office we shall still further improve that position and standing.

The industry has too long been looked upon with a certain amount of indifference by those whose connection with the engineering industry ought to have given them a clearer knowledge of the importance, utility and necessity of our craft. We can, at any rate, congratulate ourselves that at the present time we are on the way to achieve our hopes and ambitions, and are near to attain the goal that is our objective, namely, our proper place in the scientific and industrial world.

In common with many other industries, that connected with the foundry has passed through a strenuous time, through dark days when our perspective was for a time blurred and when we could not foresee the outcome. Through causes almost too numerous to name, through a number of factors over which industry had no control, we succeeded from an unprecedented period of inflation to a time of depression which has had no parallel in the world's history. This slump has been hard to face, it has been hard to fight through, and we are not yet out of the wood. We must not, however, lose heart. Rather should we take advantage of the times to put our house in order, so that when better times come, as in the cycle of trade conditions is inevitable, we shall be able to hold our own both at home and abroad.

Speaking as an employer, I want to extend a very hearty invitation to the Council of the Foundry Trade Unions to co-operate with us in the work we are doing. We hear a great deal about better conditions of employment, welfare schemes, and other matters of a like nature. I am strongly of opinion that both employer and employee must get to know each other better. Already there is a feeling of conciliation in the air. The old hereditary antagonism that existed is disappearing, and by rubbing shoulders we are obtaining the other man's view-point to our mutual advantage. After all, what is success worth if it is not shared by all those who have helped to bring it about? It is essential that we

must improve the conditions under which our employees work.

It will pay us to consider the causes which have kept our industry from progressing as we would have wished it. Do we get the best class of apprentices; and, if not, why? I venture to suggest that we have not made our foundries and the trade sufficiently attractive. We may not in the past have given much thought to the training of apprentices. The whole system of the continuation of their education between the ages of 14 and 16 wants very careful consideration and thought. There is an old saying, "Catch 'em young." When the youth is at his most receptive age we should see that the knowledge imparted to him will not only make him a better craftsman, but will broaden his outlook and make him a better citizen. It is possible under the comparatively new Education Act to shape the continuation courses so that this can be accomplished.

Proceeding further, have we always in the past selected the best men for our managers and foremen? Many of them had little opportunity in the past of making themselves efficient in scientific and commercial matters. I refer to the time before the Institution of British Foundrymen came into existence. It is well to consider whether employers in selecting their managerial staff make sufficient use of the Institution; in fact, do they use it according to its deserts? I am strongly of opinion that more pressure should be brought to bear upon employers to select their managerial staff from members of the Institution of British Foundrymen. This should be the reward of those members who are taking a keen interest in their work and consistently endeavouring to make themselves more efficient by continuing their education outside the ordinary working hours.

I am a great believer in the efficient training of apprentices, because I fully believe that by strict attention to this matter the ultimate success of the industry will result. The members will call to mind that some years ago the method of training apprentices was taken up by the Institution of British Foundrymen, but nothing of a definite character resulted, owing mainly to the incidence of the war. It is exceedingly gratifying to note that the subject is again to the fore and that good work in many directions is being accomplished. In some cities the Education Authorities have recognised the wisdom and benefits accruing from the promotion of Junior Technical Schools, where the education of boys is continued between the ages of 14 and 16. It is during this period that the youth *finds* himself, as it were, and has a better appreciation, which enables him to select the particular trade for which he is best suited.

In Manchester there are two such schools, and a possibility of an addition to this number in the near future. The employers have representation on the local Committees of Management, and it is gratifying to find that those best able to advise are being brought into consultation. The work is being carried out in a thoroughly practical manner. Visits to local works and foundries are arranged for the boys and modern plant, loaned by the employers, is at their disposal for study. It is in the receptive years of a boy's life that we should endeavour to give him the best and most efficient education possible. During his continuation course, education on sound practical lines should be imparted which is designed to make him efficient in both a general and a technical sense. I hope the day is going—even if not past—when the only desire of parents is to get their children into a works in order that they may benefit by the wages brought home.

I think you will agree that very many of the real difficulties experienced in the foundry are due to lack of whole-hearted co-operation. By that I mean an absence of free discussion and consultation between the various departments, the drawing office, pattern shop, foundry and machine shop. If there was freer co-operation which would eventually lead to a clearer understanding a great many of the difficulties now experienced would be obviated, and, moreover, much expense saved.

You will have noted from the Report that the British Cast Iron Research Association, as a result of steps taken in 1919, has now been formed and incorporated. This result must be extremely gratifying to all our members, as it was largely owing to the interest taken by them in the early stages that the Association was formed.

It took a war to bring about a due realisation of the value of Research to Industry. Prior to the years 1914-1918 the Universities were too academic, and were loth to associate themselves with trade or industry in any shape or form. To-day the attitude adopted is a totally different one, and the closest association now exists between what one may term the technical scientist and the producer. It is impossible to foresee the wide-reaching effect such a co-operation will have upon industry, and in particular upon the work, which members of this Association are engaged in. Therefore, I sincerely trust that employers will do their share in promoting research and give it every possible help. There is no reason whatever why there should be any clashing between the work of this Institution and the Association. Rather would I say that their work is complementary, and by useful aid the results secured from each rendered more valuable.

In the investigation of problems, samples of a satisfactory and unsatisfactory or defective character are being collected. Chemical, microscopic, physical and heat-treatment tests are being carried out and a thorough investigation made. Reports are duly issued to members upon the tests carried out. Even in the comparatively short period of the Association's activity beneficial results have been secured and enjoyed by members interested in the problems submitted.

We should consider the fact that in this country there are something like 3,000 foundries, and at one time we were the largest producers of malleable cast iron in the world. Our output to-day of 66,000 tons per annum is less than it was some years ago. From the foundries of our American friends 1½ million tons of malleable cast iron is turned out per annum, or an average of 100 tons per week per foundry, against our average of 8 tons per week per foundry. To-day we are purchasing large quantities of pig-iron, to say nothing of large amounts of iron and steel castings from abroad. It behoves us, therefore, to give our whole-hearted support and assistance to the industry if we are to improve conditions and maintain or better our position in the world's markets. It is not a question to-day of the lone hand. There must be complete co-operation through the foundry and throughout every workshop in the kingdom. What is required is a square deal, and the employee, as much as the employer, must recognise the fact that no effort must be spared in order to secure again our industrial supremacy. Understanding is broadening, and it is appreciated that the economic conditions prevailing have a direct bearing upon all engaged in industry. Given complete understanding of this fact, we shall find an increase in efficiency, and I, for one, believe that by securing that efficiency we shall place ourselves in a position which will not be shocked or beaten by foreign competition.

Gentlemen, in conclusion, allow me to thank you for the honour you have conferred upon me by electing me President of the Institution. As a final word, I wish to thank my predecessors in the office for the able work they have accomplished, which enables me to take over the Presidency of a highly organised efficient Institution.

DISCUSSION

MR. H. L. REASON said he had very much pleasure in proposing a very hearty vote of thanks to the President for his address. They had listened to other presidential addresses from men of varying calibres and qualifications—chemists, metallurgists, foundry managers, and proprietors. It was this combination that made their meetings so interesting. It was a good thing for those employed to be able to attend a meeting of this description and listen to the views of an employer.

Mr. Stubbs, in his address, dwelt upon the value of co-operation; he showed a strong desire to bring foundries up to the highest pitch of efficiency, and he realised that such efficiency could only be obtained by the co-operation of the draughtsman and the pattern-maker with the foundry and the machine shop. If the majority of employers would

take the same view foundrymen could look forward to the future very optimistically.

The boy question had always been present in presidential addresses—the question what could be done to improve the status of the industry and bring highly intelligent lads into it. The remarks of the President would stimulate boys to take an interest in the industry, and induce their parents to consider it as a suitable industry for an intelligent lad. Another point in the Address that appealed to him was the passage about appointments. He had never before heard it mentioned in a presidential address, but he agreed with Mr. Stubbs that the Institution ought to be made more useful in that direction. There should be a medium by which the names of members in want of employment would be brought before other members if they desired it. He did not think they had such a medium at present. Very important appointments had been filled up in accordance with recommendations from the Institution, but with the President he did not think that had been carried as far as it might have been. He anticipated that the Cast Iron Research Association would be a great help to the Institution, obtaining for it the information which was required to educate excellent craftsmen, and as time went on the Institution would grow until it became one of the most important of its type in this country.

The vote of thanks to the President was put to the meeting by MR. RIDDELL and carried by acclamation.

The PRESIDENT said one of his most pleasing duties was the announcement of the step taken by the National Ironfounding Employers' Federation, of which he had had the honour to be president for the past six years. It covered the whole of Great Britain and Ireland. He had received from the secretary the following letter, dated August 15:—"I have pleasure in informing you that at a meeting of the Executive Board of this Federation held on the 15th prox. the members received with pleasure the announcement that you had been appointed President-elect of the Institution of British Foundrymen, and the following resolution was unanimously passed. That the hon. treasurer of this Federation be empowered to expend a sum not exceeding £200, the sum decided upon to be invested in the hands of trustees of the Institution of British Foundrymen to be used to establish a medal to be termed the National Ironfounding Employers' Federation Medal, to be awarded annually upon terms and conditions to be arranged. I shall be glad if you will kindly bring this matter before the Executive of the Institution of British Foundrymen and advise me in due course as to what steps they propose to take in regard to this subject.—Yours, etc., J. A. S. Hassall, secretary."

He formally moved that the offer be accepted and that it be left to the Council to decide what form the gift should take. He also proposed that the best thanks of the Institution be given to the National Ironfounding Employers' Federation.

MR. RIDDELL said he would second that motion with great pleasure. At the same time he might mention that Mr. Mayer had done something of a similar nature for the Newcastle and Scottish Branches. Mr. Mayer had purchased a piece of ground in Glasgow, and the right to collect the rents of it had been vested in trustees. It would provide £26 a year for all time, and out of that sum they were to provide a gold medal and a silver medal to be competed for by members of the Newcastle and Scottish Branches. He thought the motion should incorporate a vote of thanks to Mr. Mayer.

The PRESIDENT put the motion to the meeting in the form that the best thanks be given to the National Ironfounding Employers' Federation and to Mr. Mayer for their gifts. This was carried unanimously.

Election of Trustees and Auditors.

MR. RIDDELL moved that Messrs. R. Buchanan, F. J. Cook and W. Mayer be continued in the position of trustees.

The PRESIDENT seconded the motion, which was carried unanimously.

MR. J. G. ROBINSON (Halifax) proposed that Messrs. J. & A. W. Sully, chartered accountants, of Queen Victoria Street, London, be appointed auditors. He explained that the former auditors, Messrs. Frank Creke, Harcourt & Company, were a Birmingham firm, and were originally elected when the secretaryship was a movable feast. At the present time the secretary resided in London, and it was much better that he should be in touch with auditors close at hand than that he should have to go to Birmingham to have his books audited. There had been no fault to find with the previous auditors in any shape or form.

MR. W J. FLAVELL seconded the motion, which was carried unanimously.

THE BASIC HEARTH ELECTRIC FURNACE PROBLEM.

(*See page* 236.)

The PRESIDENT said they were much indebted to Mr. G. K. Elliott for the Paper he had prepared for presentation to the Institution. Mr. F. J. Cook had prepared a similar Paper which would be read at the meeting of the American Foundrymen's Association. He welcomed very much this exchange of Papers, and his only regret was that Mr. Elliott could not be present to read it. He asked the members whether it was their wish that a cable be sent to their friends of the American Foundrymen's Association expressing their appreciation of Mr. Elliott's Paper.

The cable was worded as follows:—

"Behalf officers, Council, members, assembled annual meeting, accept deepest appreciation excellent Paper contributed our programme, George Elliott, advise author, best wishes.—Institution of British Foundrymen.

MR. T. D. ROBERTSON, M.Met., of London, then read Mr. Elliott's Paper

After the Paper was read the PRESIDENT said they were very much indebted to Mr. Robertson for the very clear manner in which he had read the Paper. They would have an opportunity of expressing their best thanks to the author at the next morning, and he suggested that one hour be allotted to the discussion of the Paper before going on to Mr. J. Shaw's Paper upon "Some Perplexing Foundry Problems."

Colonel Cheesewright's Offer.

The PRESIDENT also announced that Colonel Cheesewright, D.S.O., being impressed by the remarks in the Presidential Address in regard to making provision for unemployed members, had offered to put four insertions in THE FOUNDRY TRADE JOURNAL when any member subscribing to the Journal was in want of a situation. On behalf of the members, he thanked Colonel Cheesewright for this generous offer.

Next Year's Conference and Exhibition.

The PRESIDENT said it was usual to decide at this meeting the place of the next annual conference. The recommendation of the Council was that it be held at Birmingham. Some of their friends in Birmingham, outside the Institute, the Birmingham Chamber of Commerce, were preparing what was going to be the finest exhibition of its kind in connection with the foundry trade which had been known in this country, and it would be very opportune to hold the annual conference in the city where the exhibition was being held.

The members signified their approval.

The PRESIDENT asked the members to show their appreciation of the excellent way in which the work of the Institution had been carried on during the year by the secretary, Mr. Hollinworth This was done by acclamation, and the morning's proceedings came to an end.

Civic Reception.

In the afternoon there was a civic reception by the Mayor and Corporation in the Town Hall to which the ladies were specially invited.

Annual Dinner.

Mr. Stubbs presided at the dinner in the evening at the Palatine Hotel. Unfortunately, the Mayor was unable to attend, and his place was filled by the Deputy-Mayor, Alderman E. P. Howe, who was accompanied by Alderman Joseph Heap, J.P. The musical programme was arranged by Mr. J. Woof Gaggs, musical director, The Tower, Blackpool. After the loyal toast of "His Majesty the King, Duke of Lancaster, and Members of the

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Royal Family." MR. R. BUCHANAN proposed the toast of "Blackpool." This was responded to by ALDERMAN HOWE. The toast of the "Institution of British Foundrymen" was proposed by ALDERMAN HEAP. He said he was glad to be present when the Institution was conferring the honour of its presidency upon Mr. Stubbs because he had long known the family of which Mr. Stubbs was a member. The position of President of the Institution would never be held by a man of higher character than Mr. Stubbs. Since coming amongst them he had been very much impressed with the importance of their work, and it undoubtedly had its influence upon Blackpool, which depended upon industrial prosperity. In working for the Institution the members were bound to do a great deal for the country. It was a splendid idea to bring together in one organisation masters and workmen to work together for the interests of the industry, and it was well expressed by the motto of the Institution, "Science hand in hand with Labour."

In replying, the President thanked the representatives of the Corporation for the great kindness they had shown. They had come and they would go away again, but he did not think any would regret that they had come.

Second Day's Proceedings.

Death of a Prominent Member.

The first duty of the President on this day was a sad one. He announced the death of Mr. Smith, formerly of Birmingham, afterwards transferred to the Coventry Branch, who had intended to take part in the Conference and engaged a room, but was prevented from coming by an accident which had a fatal termination. As an expression of their feelings the members rose, and remained standing for a short time.

DISCUSSION ON THE BASIC HEARTH ELECTRIC FURNACE.

The discussion on Mr. Elliott's Paper was opened by MR. RIDDELL, who said perhaps it was right that he should be the first to express his views because he had the opportunity of reading the Paper before it was submitted to the Council, and he told the members that it was a very good one. They were all much indebted to Mr. Elliott for the immense trouble, pains and care that he had taken in its preparation. Seldom did they get a Paper which contained so much useful information; it was to him a text-book on the working of iron in the foundry, and what he particularly liked was that it was not biased. In Papers of this description, one was accustomed to find that a man who had experience of a particular type and was very biased in his expression of opinion, and when he heard that the Institution was to have a Paper from Mr. Elliott on this subject he anticipated an account of different kinds of electric furnaces and strong advocacy of the electric furnace as the method of working iron. In fact, however, Mr. Elliott said it was only under certain conditions that the electric furnace could be used with advantage in the foundry. He entirely agreed with that statement; he would go further and say the same thing applied to the cupola. Even in the cupola good economic results could only be obtained under certain conditions when intelligent men were working it. The members would have noticed Mr. Elliott's statement regarding the superheating of iron in the cupola. He himself had always maintained—he expressed his views in a Paper he gave at Sheffield—that for giving superheat the cupola was one of the most ridiculous melting apparatus that was ever invented. He knew there were several people against him on this point, but his contention was that the cupola could not superheat iron in the true sense of the word.

Although he had no practical experience of the electric furnace, and was in the position of a spectator, he had seen one or two, and he was much impressed with the amount of superheat that could be obtained. One could imagine many occasions when that would be very useful and advantageous. Mr. Elliott had pointed out that grey iron had more of what was termed quasi-superheat than white iron. He would add to Mr. Elliott's remark that the melting point of iron, whether white or grey, depended on the amount of combined carbon in the iron at the time it entered the melting zone. If the approach to the melting zone was slow the amount of the combined carbon would increase in the iron proportionally to the slowness of the approach. Foundrymen did not always get such fluid iron as they expected, and the reason was that the iron before it could enter a zone where the temperature was high had to pass through a lower temperature zone where the carbon was changing very rapidly from the graphite condition to the combined carbon condition. What he did in his own practice was to try to keep the temperature of the upper part of the cupola stack as low as possible and to concentrate heat in the melting zone, and one method was to put a hose pipe on to the coke. The heat which otherwise would go to raise the temperature of the pig-iron was consumed in driving off the moisture which was in the coke. The coke was in a cooler state, and the result was that there was not such a big zone of high temperature above the critical point, the metal reached the melting zone with less alteration in its combined carbon than it did when dry coke was used. The idea had been so successful that his cupola man, who saw the benefits, refused to use coke not so treated, and for light castings they had been able to melt iron with 1½ cwt. of coke to 1 ton of iron melted.

The points brought out in the Paper would be found as instructive in cupola working as in the electric furnace, and they were much indebted to Mr. Elliott for puting forward suggestions which would guide them in their own practice.

MR. J. R. HYDE (Sheffield) said he was one of the ironfounders who had leanings towards an electric furnace, and about five years ago put in an electric furnace. It was not done for either of the two reasons mentioned by Mr. Elliott, but they had found it very interesting if not profitable.

Mr. Elliott, in his Paper, referred very clearly to the fact that the casting temperature was an important factor in determining the quality of cast iron, yet in preparing the very interesting table of results he entirely omitted to mention the casting temperature. Considerable research had been done in England on the strength of test bars, as related to casting temperature, and it was always found that the casting temperature was an important point, but most of the work was limited by the casting temperature of the cupola. The electric furnace was spoken of as adding superheat. Were they not getting an improvement which was due to the higher casting temperature rather than to the inherent qualities—good qualities he assumed—of the electric furnace. The fact that the transverse tests stated in the Paper were made with bars 1¼ in. in diameter on 12 in. centres made it difficult to compare his evidence on that head, because that was a bar which he had not used in his laboratory, but he would like to give his results. The transverse strength in cwts. of the 1¼ in. round bars, 12 in. centres, seemed to be 20 per cent. higher than what was got on the British 2 x 1 size of bar tested between 36 in. centres. Working backwards it appeared that if they took the No. 1,221, with a transverse strength of 25 cwt., and tested it by the English standard, it only gave about 22 cwt. Now, in his foundry, they used good and indifferent iron, but he had never seen a test bar that would only carry 22 cwt. on their 36 in. tests. When they got the duplexed iron after it had been through the electric furnace, the 36 cwt. transverse strength translated to the British 36 in. centre bars into 30 cwt., which was only just good enough to meet most of their engineering specifications. Many of the tests given by Mr. Elliott, even when the material had been through the electric furnace, were only ordinary London engineers' requirements, which were met in the British foundries every day, and therefore the duplex process was hardly necessary except for very special mixtures. He could not see that to those, who had got an electric furnace, it was going to be any advantage to put the iron through it in order to arrive at the same results as they were now getting. Recently they had run off some results with the 1¼ in. round bar, and found that when cast hot they could obtain 36 cwt. on the material: when the iron was allowed to wait for a matter of seven minutes before pouring, they only reached

34 cwt. in the transverse test—a drop of 2 cwt. He was wondering to what extent the improvement in the electric furnace iron was due to the higher superheat.

That referred to the question of the tests, and in regard to another interesting feature, the reduction of sulphur, the figures given were in accord with his experience, and he could endorse them in every way, but he did wish that too much credit be not given to the elimination of sulphur for the improvement of the cast iron. He was too young to put his own opinions against some of the older members, but he was not going to give to lower sulphur any of the credit for the improvement of the cast iron.

There was the vexed question of oxide. The two Papers presented to this conference had opened his eyes to the influence of oxide on iron, and he had set to work to see what the effect was. In the opinion of some metallurgists oxide was weakening, but others said that the presence of a certain amount, in whatever form, had an improving effect. In his own experiments he used the black oxide or millscale, and although crude he found some improvement by adding it in the ladle and stirring.

MR. V. C. FAULKNER (London) said he was still a young man, but even he, could indulge in reminiscences. Many years ago, when he first became interested in this subject of the electric furnace, a well-known professor stated publicly, before a meeting of steel people in the North of England, "To those people who think they will make steel successfully by electricity, all I can say is, 'Good night, pleasant dreams.'" He then sat down, and all those steel people cheered their loudest. But the electric furnace was going to come, there was no doubt about that; and instead of making destructive criticisms foundrymen had better indulge in constructive criticism, and find out for themselves where it was going to be of advantage. They were better placed than the pioneers, who had to design their own furnaces. The designs were first made by electrical engineers of foreign origin, then by young British metallurgists, finally some real steelworks engineers were put on to the job, and there was now British plant which could be relied on, which would not give trouble, but was in every way efficient. British electric furnaces were found throughout the world, in Europe, Asia, South America, even in North America. In Great Britain there were four types which might be considered standard, and three of them possessed conductive hearths. A great deal had been said in the States and in Great Britain as to the disadvantages of the conductive hearth, but that criticism had been completely washed out and a foundryman could take any one of those four types of furnace and be assured of success. The process was quite simple. Using a little metallurgical common sense the temperature could be raised to just what was wanted, the limit being the melting point of the refractory materials, and the foundrymen could then go ahead.

This paper had been put most excellently by Mr. Elliott. It pointed the way to something which foundrymen would take up eventually, and make a success of. There was nothing in the way except the question of cost. Perhaps Mr. Robertson would tell them what he thought would be the cost. He was quite sure that for Birmingham or Sheffield the cost was not going to be as high as Mr. Elliott stated.

MR. H. J. YOUNG (Wallsend-on-Tyne) said those members who had to do with trade knew what they obtained for their castings, and there were very few who could get a price which would justify the use of an electric furnace, however good it might be. He did not think they knew everything about the cupola. It was a most wonderful furnace, the cheapest of all, and they ought to see what they could do with it before going on to the electric furnace. He had made a good many of these American arbitration test bars. Looking up his data he found that he had cast over 2,000 pairs of these bars, of which 1,134 pairs had been analysed in duplicate. 74 pairs gave 0.075 per cent. of sulphur or less, 248 pairs gave 0.076 per cent S. to 0.099 per cent., 469 pairs gave 0.100 per cent. S. to 0.139 per cent., 343 pairs gave 0.14 per cent. S. or more. Therefore in over ten years of work in two foundries only 6½ per cent. of the castings would have obtained Mr. Elliott's approval. Further, over 71 per cent. contained over 0.1 per cent. of sulphur, 30 per cent. of the castings contained actually twice as much sulphur than Mr. Elliott said was the extreme limit of safety.

Since reading the Paper he had carefully examined his records, and he found that not from any point of view, and not in one instance had the lower-sulphur castings given superior results. The analyses of 1,134 pairs of test bars, representing more than double that number of castings of all kinds, gave not one tittle of evidence in support of this low-sulphur theory. He had also followed the literature of cast-iron over some considerable period, and he had not come across any convincing evidence about the merits of low sulphur. These were not opinions that he was giving; they were facts. Castings that were hard, and drawn, and brittle, due to high sulphur content were often made, but to blame the sulphur was like blaming a powerful engine for troubles arising from weak foundations. Mr. Elliott spoke about the "two purposes of manganese in cast iron." His experience was that manganese had many more than two purposes, and he recommended young foundrymen not to accept such statements as gospel, or what they heard about sulphur, as this was not necessarily the truth. By keeping an open mind upon the subject he had been able to make progress.

From the list of transverse tests of cast iron before and after treatment in the electric furnace, it appeared that where the total carbon was reduced the strength increased, which was to be expected. But the test did not give evidence in favour of the electric furnace, and his own records of cupola-melted iron (with no electric treatment) contained hundreds of results where the best was from 34 cwt. upwards, although the metal contained a higher average content of phosphorus and sulphur than those in Mr. Elliott's table.

A curious point arose out of an inspection of Mr. Elliott's test numbered 3,419, where steel was added to reduce the carbon and phosphorus. Allowing for the effect of the electric treatment, as shown in other results given by the Author, it would appear that about 12 per cent. of steel must be added to reduce the phosphorus from 0.62 per cent. to 0.55 per cent. But the addition of that amount of steel would be expected to reduce the carbon from 3.39 per cent. to about 2,89 per cent., whereas Mr. Elliott's figures gave it as 3.14 per cent.. Then the silicon of 2.16 per cent, instead of arriving at 1.80 per cent., as would be expected, had only come down to 1.90 per cent. while the manganese increased to 0.84 per cent., instead of going down to about 0.73 per cent. Much better results could be got with the cupola than Mr. Elliott had apparently obtained with the electric furnace. Since the author gave his figures as indicative of the accuracy attained by the use of the electric furnace, it would be interesting to have from him or from his representative, an explanation of these apparent discrepancies.

They all realised that the use of the electric furnace would enable them to pour at higher temperatures, that slag and such like impurities would separate more freely, the carbon content could be more easily controlled, and new constituents added; but apart from these facts little could be said at this stage. Mr. Elliott's Paper gave them nothing more. In a few years' time the foundrymen would come down to the facts, that cast iron contained sulphur, phosphorus, and manganese. If those constituents were taken out they got steel. The cast iron of the future would contain those ingredients; to eliminate them was not necessarily a good thing—certainly the elimination of sulphur was not. It would be very interesting for the British Cast Iron Research Association to take hold of the sulphur problem, and once and for all prove scientifically, and also practically, to every foundryman, that the sulphur in cast iron could be controlled. Mr. Elliott seemed to say that by using scrap they would get a higher sulphur content, which would increase with every re-melting. This is not true. It was most difficult to make high sulphur iron. There were limits to the sulphur. As far as he could see no danger need be apprehended unless it exceeded 0.2 per cent., and it was very difficult to produce an iron with more

than that. He was not speaking against the electric furnace, he was criticising the points which Mr. Elliott made in its favour, which he did not think were convincing. The electric furnace would be useful in its place, but in his opinion not on the lines suggested by Mr. Elliott.

MR. EDWARD SMITH (South Shields) asked whether the superheat of the electric furnace had the effect of hardening the metal unduly?

MR. ROBERTSON read the written contributions which had been sent in.

Written Contributions.

MR. J. SHAW (Sheffield) wrote that he wished to say how much he appreciated the action of the American Foundrymen's Association in proposing this interchange of Papers. Nothing but good could result from it.

Coming now to the Paper itself, Mr. Elliott admits at once that so far as cost is concerned, the duplex process is much more expensive than the use of the cupola alone. This leaves two points for discussion. Firstly, are the advantages claimed all due to the duplex process, or could most of them be gained by better selection of material and better cupola practice?

Next, is there a sufficient market willing to pay these greatly enhanced prices to keep a duplex plant at full work?

One of the claims is for superheating the metal. That may be granted, but with good cupola-working, a temperature hot enough for any casting is obtained, and as high as most of the local sand will permit. If, in addition to the first cost of the electric plant, overhead and labour charges, there is to be added special sand or composition and extra risk to the moulds, the cost of steel castings is being approached. The possible refining action of the basic hearth electric furnace constitutes its chief claim for attention so far as grey iron castings are concerned.

Mr. Elliott states that it is possible to reduce the sulphur to any limit, given time and a suitable slag, without reducing the carbon, silicon or manganese to any great extent. From inquiries made in Sheffield that statement is confirmed. But that fact, combined with deoxidation, does not account for the 33 per cent. gain in strength in the test bars given in Mr. Elliott's table.

Referring to Heat No. 1,221, we should not, in this country, call an iron with 3.48 per cent. T.C. and 1.92 per cent. Si. a strong one. There must be something else to account for the large increase in strength when cast from the electric furnace other than a reduction of 0.077 per cent. S. This latter would, by its action on the combined carbon, weaken the iron. Against this must be placed the reduction of T.C. to 3.38 per cent. and Si. to 1.82 per cent., together with at least an increase of C.C. to T.C. These latter factors would account for part of the increased strength. We would suggest that higher casting temperature, but chiefly the alteration of the graphitic carbon to the temper carbon form, are the principal causes for the increased strength? The only cupola metal that we should consider a strong one is Heat No. 8,172. Unfortunately, no test result for this cupola iron is given.

With regard to Heat No. 8,182, one notices a T.C. of 2.77 per cent. for cupola metal. So far as can be learnt, nothing so low has been recorded on this side.

It is becoming more and more recognised that low total carbon is one of the chief causes for a strong iron, and Mr. Elliott might, with justice, have put this forward as one of the advantages of the electric furnace.

To sum up, Mr. Elliott has put before us a large amount of valuable information, and in most cases has proved his points. Whether there is a market for castings of such greatly enhanced costs, bearing in mind the higher tests obtained from cupola metal on this side, is for each member to decide for himself.

MR. J. ARNOTT (Glasgow) wrote:—At the outset of his Paper, Mr. Elliott remarks on the extent to which malleable cast iron and steel have invaded the field which belongs to grey iron. It must not be assumed that this invasion is simply due to the lower tensile strength of grey iron, and that it can be prevented by the production of duplex metal. By treatment in electric furnace it is possible to control and refine metal to a considerable extent, but the final product is still grey iron. Though the tensile strength is raised there is no appreciable ductility. It is this factor which has to a large extent forced engineers to use steel and malleable cast-iron castings. In many cases the latter are much inferior to grey-iron castings in soundness and general appearance. For many castings, for example, those subjected to superheated steam, cast iron of any sort is, or should be, prohibited, not on account of deficient strength, but because of its inability to accommodate the strains set up by expansion and contraction. There are, of course, very many castings for which grey iron is the best material, and if high quality is required, as in internal combustion engines, the duplex process gives an excellent product.

PROF. C. H. DESCH (University of Sheffield) wrote:—Mr. Elliott's interesting Paper deals with a question which cannot be said to be an urgent one in this country. The beneficial effects of electric melting or of employing a duplex process will hardly be doubted by the steel metallurgist, but he is likely to question the economy of such a procedure. Cupola melting is a cheap process, whilst the electric furnace is costly in working. Mr. Elliott suggests that there would be an advantage in using the electric furnace for making special castings of very high quality. Quite so, but then why not go further and make the iron into steel—that is, carry the process in the furnace to its limit? Cast iron is only steel, after all, with its continuity broken up by plates of graphite. Except for certain kinds of bearings, these graphite plates serve no useful purpose; they only weaken the metal and destroy its ductility. We put up with them because the high percentage of carbon lowers the melting point, so that we can cast the alloy from a cupola, which we could not do with steel. If, however, we use a furnace, such as the electric furnace, which is capable of giving a very high temperature, we may as well use steel, and obtain all its good qualities. I believe that this is what will be done extensively in the future. The difficulties of steel casting are being steadily overcome, and the electric furnace provides us with an apparatus, almost as easily used as a cupola, capable of giving us a product of the highest quality, in quantities small enough for the little foundry, or on any larger scale.

MR. J. E. HURST (Scottish) wrote:—In connection with the copy of Mr. G. K. Elliott's Paper on the basic electric furnace applied to cast iron, he had followed with considerable interest the earlier work of Mr. Elliott on this duplex-melting plant as applied to cast iron and also other work on the application of the electric furnace to the production of cast iron for industrial purposes.

The duplex method, as proposed by Mr. Elliot, in which the cupola is used for the primary melting of the cold pig-iron and scrap brings the use of the electric furnace more nearly to the level of a commercial proposition as far as the ironfoundry industry is concerned.

It would be interesting to learn from Mr. Elliott whether, and to what extent if any, he reduces the amount of the bed coke in the cupolas used in his duplex process. He would also be interested to be referred to the evidence on which his statement is based, "that it is probable that oxygen strengthens the iron by assisting the retention of the carbon in the combined form." It would also have been of additional interest if Mr. Elliott had included the results of the oxygen determinations mentioned, together with complete analyses of the samples, and in this connection it appears to be more reasonable to attribute the difference in fluidity which was "visibly manifested" to the higher temperature of the metal after the electric furnace treatment than to any alleged difference in the iron-oxide content of the metal at the electric furnace stage over the cupola melting stage.

The improved transverse strength values given in the table of the Paper would be expected from existing knowledge of the electric furnace treatment of cast iron.

It would have added considerably to the value of the table if the combined carbon and graphite figures had been included in addition to the total carbon content.

He was of opinion that Mr. Elliott attaches undue importance to the presence and effect of iron-oxide and the influence of the electric furnace on this constituent in cast iron. Evidence is still lacking regarding the existence of iron oxide (apart from slag) in cast iron, let alone any influence on fluidity and condition of the carbon which Mr. Elliott ascribes to it. To his mind the reduction in total carbon content of the iron after the electric furnace treatment and the considerably increased casting temperature are sufficient in themselves to account for the increase in transverse strength figures noted.

Added to this the reduction in the sulphur content of the cast iron as a result of the refining treatment at the electric furnace stage, by virtue of the reduction in amount of inclusions present, would also effect its quota of influence to the increase in strength value. It will be noticed that in all cases except two, Nos. 1,721 and 8,172, a reduction in total carbon is recorded after the electric furnace stage of the treatment. Two of these cases of reduction in carbon content have been effected by the addition of mill scale, and in the remaining cases the reduction is presumably the effect of the normal working of the electric furnace. In the two examples, Nos. 1,721 and 8,172, a slight increase of 0.01 per cent. in the total carbon is recorded. In both cases an addition of ferro-silicon has been made, and in 1872 a further addition of ferro-manganese was recorded. There is insufficient data to enable the reason for this to be ascertained, but whatever the explanation it is significant to note that the extent of the increase in transverse strength in No. 1,721 is the lowest recorded.

The increase in hardness consequent upon the reduction of the sulphur content, as explained by Mr. Elliott in his Paper, is a point of considerable interest, and on this account again the inclusion of the combined carbon figures in the table would have been of added interest.

In conclusion, he would like to add that it was with considerable interest that he read this Paper, and he is in agreement with the general conclusions of Mr. Elliott that a duplex process of this nature is an ideal method of producing cast iron of high quality. The industrial application of the electric furnace in this manner is well known to be entirely a matter of cost, and we are sure that everyone who has the interests of ironfoundry metallurgy at heart will sincerely hope for the time to come when the conditions render the application of such duplex processes possible.

MR. F. J. COOK (Birmingham) wrote:—All who had an active part in the formation of the British Foundrymen's Association will remember with gratitude the great assistance received from the American Foundrymen's Association in general and from Dr. Moldenke, the then secretary, in particular, whilst the annual exchange of Papers between the two Associations, which is now an accomplished fact, cannot fail to be of interest and profit to both.

The Paper presented by Mr. Elliott is most gratifying, showing as it does a whole-hearted frankness in giving away valuable experience gained with a unique plant at very great expense, and a broad-mindedness with which it is refreshing to meet.

Mr. Elliott has dealt very fully and convincingly with the theoretical part of the Paper, although there are points which do not quite carry the same weight here as in America.

There appears to be a difference of opinion between American and British metallurgists concerning the amount of phosphorus and sulphur allowable in strong irons. Mr. Elliott states "the irons of greatest strength contain only a small amount of phosphorus," and whilst there is nothing definitely stated as to what is meant by "a small amount" or "irons of greatest strength," yet the general opinion in America seems to place the limit of phosphorus at 0.5 per cent. In Britain one has no difficulty in obtaining greater strengths than those given in the Paper with not less than 1 per cent. phosphorus. We are convinced that the most important point is more with the way in which the phosphorus is distributed throughout the mass than (within limits) the amount present, the phosphorus when segregated tending to weakness.

Also Mr. Elliott states that sulphur above 0.070 per cent. in any ordinary grey iron must be considered dangerous. This is not in keeping with Coe's research (British Foundrymen's Association's Proceedings, 1911-12) and his experience with an iron containing 1 per cent. phosphorus, 1.25 silicon had been that the maximum physical properties have been obtained when the sulphur was 0.12 per cent.

Mr. Elliott has laid very great stress (and rightly so) on casting temperature, and has given some very useful data. If increasingly high superheat was the key to the situation, a very strong point would have been made in favour of the electric furnace, but it has to be remembered that too high a temperature is as bad as too low, as shown in the following example, taken from Longmuir's research, where an iron having the analysis of CC 0.55, GC 3.4, Si 1.78, Mn 0.28, S 1.04, P. 0.27, when casting at 1,400 deg., 1,350 deg., and 1,245 deg. C., gave maximum tensile stresses of 9.7, 14.1, and 10.6 tons per sq. in. respectively; and it must also be borne in mind that a temperature can be readily obtained in the cupola, by good practice, that will give all there is to be gained from casting temperature. This is instanced by the Hailstone's temperatures quoted by the author, those results having been obtained under ordinary practice with common work, without any special attempt at superheating.

The table of results is particularly interesting, although there is an absence of evidence given to account for the increased strength of the corresponding irons after passing through the electric furnace. Certainly there is nothing in the difference of the sulphur content to account for it, as claimed by the author. The part played by refining, *i.e.*, the elimination of oxides, etc., is difficult to estimate owing to our imperfect knowledge of the subject and inability to estimate the extent to which this has been carried. Micro-photographs of the results might have shown some difference in structure. The low carbon content of the cupola-cast metal of heat No. 8,182 is interesting to us, as with British grey cast irons we have been unable to get carbon content appreciably below 3 per cent., except in one or two cases where the drillings have afterwards been proved to have been taken from segregated areas.

The transverse test results, owing to their having been taken on the arbitration bar, to which there is no equivalent here, give no comparative idea to the average Britisher. The results have therefore been worked out on a comparison with the same material on bars 1 in. sq. and 12 in. centres, which is the nearest British test, and the results are given in the table*.

The most noticeable feature of the corresponding results on a 1-in. sq. bar is the very poor results obtained, particularly those from the cupola, which at once inspires the questions as to whether the results given are consistent with those generally obtained with like irons in America, or whether the results have been unduly influenced by casting temperatures.

We are more particularly interested in irons with a silicon range from 1 to 1.5 per cent., and, unfortunately, the test results for this class of iron, cupola cast, are missing.

In a foundry with which we are familiar it is not the usual practice to take regular transverse tests, although bars are cast on each cylinder, these tests being made only when called for by inspectors, or occasionally for comparative purposes, whilst tensile tests are made at least from every cast. With irons containing silicon from 1 to 1.5 per cent., phosphorus 1 per cent., and sulphur 0.12 per cent., the two latter being much more than the author considers safe, and on bars cast 1¼ in sq., machined down to 1 in. sq., cast on to the casting and not separate, which ensures all the ill-effects of lowering temperature, to which attention has been given, there is no difficulty in regularly obtaining better results than those given in the Paper for the electric-furnace metal, an average of 25 tests giving 35 cwts., or 3,920 lbs., on an average transverse test 1-in. sq. bar: 37 cwts., or 4,144 lbs., on the highest transverse test 1-in. sq. bar; and 34 cwts., or 3,808 lbs., on the lowest transverse test 1-in. sq. bar.

The question therefore arises as to whether there would be a corresponding increase in test results with this iron if it were put through the electric furnace, and, if so, what is the evidence? We fail

* This will be published next week.—Editor, F.T.J.

to find any that would warrant the recommendation of the additional outlay.

Mr. E. Adamson (Sheffield) wrote:—Mr. George K. Elliott is to be congratulated on the interesting facts he has given in his Paper on the Basic Hearth Electric Furnace and some problems of Cast Iron.

Mr. Elliott's table is perhaps the most interesting feature of the Paper, as definitely showing the increases in strength due to using the electric furnace. It would be still more interesting if the Author could give the deflection of the transverse tests.

The Author is wise to point out that the electric furnace is only of practical use for high-class castings, for, particularly with the present-day costs, it is doubtful if the cost of the electric furnace could be kept within $15, or, at parity value, say, £3 per ton. In this country the cost of electricity alone would be anything from 20s. to 30s. per ton of iron.

The Author states that "the hottest part of the melting zone in the cupola is about 2,200 deg. C.," and it would be interesting to know what method was used to obtain this figure. It is well known in steelworks practice that *silica* bricks "slime" or melt when the furnace is working at 2,800 deg. C., and it is also known that *fire-bricks*, which are much less refractory, fuse at a very much lower temperature.

The Author also gives certain temperatures, *e.g.*, as the metal from the cupola is leaving the taphole, entering the ladle, and pouring into mould, and if he could give a table showing such temperatures it would be most interesting to ironfounders. The table would also be of greater use if he gave the character of the metal as it was tapped and also poured into moulds. The temperatures mentioned by the author would, of course, be surface temperatures, and molten metal differs in character.

A statement by the Author is that "the most powerful factor for fluidity is superheating," and if he would correct this to *one* of the most powerful factors probably a large number would agree with him, but it is a fact that *cleanness* of iron is also a powerful factor, making all the difference in the fluidity of molten metal, as apart from differences in temperature. With fluidity not due to temperature, however, little feeding, as is commonly understood by this term—*i.e.*, with a rod—is necessary.

It may be quite true, as mentioned by the Author, that the relationship of liquid contraction and temperature is intimate, but presumably he will agree that liquid contraction has also an intimate connection with fluidity not due to high temperature.

As the Author enters in places the region of theoretical deduction, and in order to help those who have read his Paper, could he give microsections or fractures of the irons mentioned in his table, or of at least some of the metal as it left the cupola and as cast from the electric furnace, giving casting temperatures and size of bar used?

With reference to the Author's mention of nitrogen in cast-iron, Dr. T. Baker found, when he obtained a sound tube connection, he could not find nitrogen in steel, and if this is correct there would probably be none in cast-iron.

With regard to the influence of oxygen, no exhaustive work has been published, although J. E. Johnson and W. L. Stork show that iron containing oxygen is stronger than iron with less oxygen, but considerably more information is required before a definite opinion can be formed as to whether this phenomenon is actually due to oxygen *per se*, or whether a less quantity of oxygen, as the Author suggests, gives the higher test

Another interesting point in the working of the electric furnace is, how does high silicon up to 2.30 per cent., as shown in his table, or, say, an average of 2.00 per cent., affect the basic lining of the furnace? Does the silicon oxidise and attack the lining materially on the slag line of the bath, and what is the chemical composition of the slag in order to obtain the chemical reaction as suggested?

With regard to the influence of sulphur in iron the general opinion, certainly in ordinary foundry irons, is that 0.10 per cent. of sulphur is quite allowable, and by no means detrimental.

The Author states that the addition of ore or scale removes most of the carbon by de-oxidation, but it is well known that in ordinary Siemens furnace practice silicon goes before carbon. Does the Author claim that the reverse to Siemens furnace action is due to the temperature which he obtains in the electric furnace? As, if so, scientific proof would be of great value to metallurgists.

Mr. Robertson's Reply.

Replying to Mr. Shaw's remarks, I would state that I believe there is a field for grey iron castings of a quality from which such tests are required, as cannot usually be met, by melting a strong mixture of irons, and at the same time have sufficient fluidity to be poured into satisfactory castings, using the ordinary cupola.

The cost of electric refining is all additional, but it must not be forgotten that it is possible to use cheaper mixtures of pig-iron and scrap in the cupola, when working in conjunction with the electric furnace, the final composition and casting temperature being adjusted in the electric furnace before pouring.

The first cost of electric furnace plant is probably a serious matter, but the operating costs are not nearly so high as would appear to be generally imagined.

Replying to Prof. Desch's remarks, I would say that the urgency of the question depends largely upon the difficulties that any particular foundry are experiencing with their castings. Whilst there is no doubt that steel castings could be used with advantage to replace many castings now made in grey iron, we must not forget that the grey iron casting is much cheaper to machine than the corresponding casting in steel, and consequently it is still in the interest of the ironfounder to make his castings of as good a quality as possible.

Mr. Arnott's views will, I think, be endorsed by the majority of our members, and do not call for comment.

The question of the reduction of the amount of bed coke is one which, of course, must be referred to Mr. Elliott, as also must be the questions concerning the effect of oxygen.

Mr. Cook's interesting comparative remarks I propose to hand over to Mr. Elliott for his comments. Several interesting points are raised, and a table has been given which will enable members to compare the results obtained in the United States with a bar 1¼ in. in dia. with our more familiar bar of 1 in. sq. section. The formula which Mr. Cook has used for his conversion is not given, and might prove of interest to our members for future reference.

The improvement in quality of all irons mentioned by Mr. Elliott, after treatment in the electric furnace, seems to be well marked in every case, and I see no reason why even better results than those quoted by Mr. Cook would not have been obtained had the metal in question been subjected to the duplex process, employing the electric furnace.

Mr. Adamson's remarks *re* the deflections of test-bars is of interest to members and will possibly be supplied by Mr. Elliott. As to question of cost, the high power costs in this country undoubtedly handicap electric furnaces. Power costs here are two to three times those in the States, but coal will come down in future and costs other than power, *i.e.*, labour, electrodes, slag forming materials, and repairs are comparatively small, totalling probably not more than, for a 4-ton plant, say, 10s. to 15s. per ton treated.

The temperature of hottest part of the melting zone is given as 2,200 deg. C., and probably refers to the centre portion of cupola, and is, of course, higher than that experienced at the brick walls. Regarding the temperatures of the metal, it is, of course, obvious that using optical pyrometers somewhat erroneous results may be obtained when the metal has a scum on its surface.

With reference to fluidity and superheat, Mr. Elliott states that the most powerful factor for fluidity is superheat, and immediately qualifies this by mentioning other factors which have a bearing on fluidity. I am inclined to support Mr. Elliott's contention, as without sufficient superheat, even if the other factors are favourable, the

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metal would still run cold, and even with the other factors unfavourable a sufficiently high temperature for the metal would still ensure a fully run casting.

The question of nitrogen and oxygen is one on which I would rather not give a definite opinion. I believe that until reliable methods of chemical analysis are developed for the determination of these gases in iron and steel that there is a danger of reaching erroneous conclusions because of having false data on which to work.

The silicon in the iron has no deleterious effect upon the basic lining of the furnace. It does not become oxidised to silica and therefore does not tend to make an acid slag. The composition of the slag used for refining cast iron in the electric furnace is very similar to the finishing slag used in electric steel making. It is composed of lime with fluor spar and either sand or fireclay added to give sufficient fluidity. In refining cast iron as in the better-known process of electric steel making, desulphurising only takes place when the slag condition is deoxidising, *i.e.*, with a slag practically free from iron oxide.

The carbon added for deoxidising purposes floats on the top of the slag and does not enter the metal. It burns with any oxygen in the furnace atmosphere to the exclusion of that oxygen producing a dense smoke and strongly reducing conditions. The metal is deoxidised without the removal of any silicon or manganese.

The question of the oxidation of carbon in preference to silicon I will leave for Mr. Elliott, but will mention that in steel making in the electric furnace the removal of silicon is sometimes a matter of difficulty, and it is quite possible that the order of preference in Siemens' furnace practice may be reversed in the electric furnace.

Regarding the certainty in regard to the product even after treatment in the electric furnace, I would like to point out that the electric furnace does eliminate some possibilities of trouble, owing to the fact that samples may be taken every few minutes during the refining process, from which samples the fracture and the temperature can be judged and conditions altered accordingly.

The discussion that morning had been interesting. Mr. Riddell raised no questions that required reply, but his remarks were appreciated by everybody. Judging from the written communications and from what had been said, he certainly thought the members considered the improvement in the quality of the electrically refined iron was due mainly to the increased casting temperature rather than to the elimination of sulphur or oxygen from the iron. There was this to be said for the electric furnace—that it could be operated according to one's own ideas; if the foundryman thought the iron was improved by taking out the oxygen, he could take it out, if not he could leave it in. But he could not take out the oxygen without taking out the sulphur at the same time; or he could take out the sulphur and still have oxygen in the iron by carrying out desulphurisation and deoxidisation in the ordinary manner, and then add some mill scale in the ladle, as Mr. Hyde suggested he had tried, to give the oxygen wanted.

Mr. Faulkner asked about the cost of the electric furnace. Mr. Elliott, in his paper, had scarcely touched upon this matter, and if he had done the conditions in this country were so different from those in America that the figures would not have been of any real value to British foundrymen. Unfortunately, we had no water power; all the power had to be generated by dear coal, and costs in this country, he should say, on the average were two to three times as high as the corresponding costs in America. That was quite a serious handicap. But the amount of current required for the refining of cast iron was nothing like so great as that required for an electric steel furnace, and he personally was of opinion that they could obtain all the benefits of this duplexing process with a considerably less consumption than the 200-kw. hours per ton of metal estimated by Mr. Elliott. They could leave the metal in the furnace for a shorter time and yet be able to get the benefits desired. In a fairly large furnace it would be possible to carry out the process with a current consumption of 120 to 150-kw. hours per ton of metal.

He was sorry that Mr. Elliott was not present to reply to the long and interesting criticism offered by Mr. Young, because it was a part of the subject with which he was not very familiar, and it should be forwarded to Mr. Elliott, who would reply in writing. To his mind it struck at the root of the matter. If it was possible to get all the desired results by improving cupola practice, there appeared to be a very small field for the electric furnace, but, on the other hand, if they could not make castings as cheaply or as well as they wished to make them, the electric furnace would have to be called in as an aid to the cupola. As far as this country was concerned there would be no question of supplementing the cupola by the electric furnace; they would never have power cheap enough to melt the whole charge of iron in the electric furnace, which would always have to be done in the cupola.

Mr. Smith asked a question about superheat having the effect of hardening the metal. He had no data on that matter, but he was quite sure Mr. Elliott would have taken note of it, and he might supply some information.

The PRESIDENT said the members would all agree that the London Branch was to be complimented on having such an efficient and capable member as Mr. Robertson. They were much indebted to him for reading the Paper and dealing with the discussion. On behalf of the members he thanked Mr. Robertson. The criticisms, written and verbal, along with Mr. Robertson's reply, would be sent to Mr. Elliott, and he would be asked to send a written reply. When that arrived a complete report would be sent out to each Branch, with a recommendation that the subject of the electric furnace be further discussed before the general body of members. He was quite sure that very much benefit would result.

Mr. Robertson replied that it had been a great pleasure to him to read the Paper, and the Blackpool Conference would leave a pleasant memory in his mind for many years.

List of Members attending the Conference.

J. W. Athey (West Bromwich), W. H. Blackburn (Walsall), Robt. Buchanan (Birmingham), F. Batty (Sheffield), G. Buchanan (Birmingham), A. Clark (Audenshaw), Col. W. F. Cheesewright, D.S.O. (London), J. Cameron (Glasgow), J. D. Carmichael (Newcastle), R. Carrick (Shipley), J. J. Collin (Sunderland), W. H. Cook (Heaton Chapel), J. Crank (Bolton), D. Dalrymple (West Bromwich), E. Doughty (Manchester), J. Ellis (Past-President, London), C. H. Evans (Birmingham), H. Cole Estep (London), Jas. Feasey (Lincoln), H. Field (Birmingham), Thos. H. Firth (Past-President, Sheffield), W. J. Flavell (West Bromwich), V. C. Faulkner (London), John Haigh (Wakefield), J. Hogg (Burnley), A. Hodgson (Manchester), John R. Hyde (Sheffield), R. Hargreaves (Manchester), B. Hopkinson (Loughborough), Thos. Hill (Airdrie), W. J. Hollinworth (Gen. Sec., London), H. Jewson (Junior Vice-President, Dereham), Lawrence Jackson (Sheffield), J. R. Jarmy (Gillingham), F. H. N. Lane (Coventry), John Little (Past-President, Manchester), T. W. Markland (Bolton), W. H. Macdonald (Sheffield), T. McFarlane (Birmingham), Hilton Mills (Manchester), A. Morris (Sunderland), W. H. Meadowcroft (Tyldesley), F. J. McGraw (Chesterfield), C. Moodie (Beeston, Notts.), H. P. Mason (Barrow-in-Furness), C. Mace (Manchester), W. H. Moore (Birmingham), W. O'Keefe (Birmingham), E. Oakden (Fallowfield), J. Pell (Burnley), Chas. B. Pugh (Secretary, South Staffordshire Iron and Steel Institute, Walsall) F. S. Perkins (Newcastle, Staffs), J. G. Robinson (Halifax), Matt. Riddell (Past-President, Falkirk), T. D. Robertson (London), H. A. J. Rang (Newcastle), H. L. Reason, (Vice-President, Birmingham), W. Rawlinson (Bolton), Oliver Stubbs (President, Manchester), H. R. Shackleton (Keighley), Edward Smith (South Shields), H. Sherburn (Warrington), W. H. Sherburn (Warrington), Jas. Smith (South Shields), A. Sutcliffe (Bolton), E. Stevenson (Nottingham), Wm. Sykes (Sheffield), J. Shaw (Sheffield), Jos. Simkins (Manchester), H. Toplis (Manchester), H. Thompson (Bolton), Thos. Vickers, C.E. (Secretary, British Cast Iron Research Association, Birmingham), W. Whitehouse (Birmingham), H. Winterton (Birmingham), D. N. Wood (Birmingham), H. J. Young (Wallsend).

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The Basic Hearth Electric Furnace and Some Problems of Cast-Iron.*

By George K. Elliott.

Although interest in the electric furnace is alive and spreading, the great mass of grey-iron foundrymen are still not well informed about it and look upon the occasional adoption of the electric furnace for such common material as cast iron as either foolish extravagance characteristic of the times, or a display of metallurgical affectation. Decidedly this is not the writer's view, for he believes not only that the electric furnace when coupled with the cupola will gain a widespread use in iron foundries, but also that as it attains this, it will prove a bulwark against the alarming tendency of malleable cast iron and steel castings to effect a permanent invasion of a field that by rights belongs to grey iron. Such invasion actually began during the war, when all branches of engineering pushed on toward super-qualities in metals.

The first published accounts in the United States of a working process for grey cast iron involving the electric furnace were two papers read by the author in 1919.† The first use of the electric furnace upon a large manufacturing scale for grey-iron castings was probably in an important metallurgical plant specialising in valves at Cincinnati, Ohio. There, at first, it was used for melting and refining cold charges of pig iron and scrap, but soon the process underwent a metamorphosis, becoming a duplexing one that involved the use of the electric furnace and the cupola in tandem operation, the melting being done in the cupola and the remaining operations in the electric furnace. At this plant both the cold-charge melting and the duplexing processes were employed for making grey-iron castings for valves that were to handle power steam of great pressure and high temperature. Some years ago steam engineering reached the point where the staple grades of iron valve castings were unreliable for the service expected. The resultant research discovered that the basic-hearth arc electric furnace of the common types in vogue for steel could produce grey iron of a better quality than any that previously had been commercially attainable. That was over four years ago, and electric furnace processes in that pioneer foundry have been in constant use ever since, and also have spread to other foundries in various widely scattered parts of the country. The duplexing process is employed on the largest scale probably in a pipe foundry that passes over 200 tons of grey iron through the electric furnace every 24 hours.

The purpose of the Author in presenting this Paper is to record for the Institution of British Foundrymen some of the main reasons why the basic-hearth electric furnace has vindicated its use for cast iron wherever attempted with discrimination, and why it is likely to do so in all foundries where practice has shaken off the shackles of the crasser forms of competition, pressing on to that enviable position where extreme quality is the first and only *desideratum*.

Because the cupola is almost the only furnace for melting iron for castings, a few reverberatory furnaces being exceptions, the electric furnace will have to bear strict scrutiny in comparison with the cupola and show noteworthy advantages over it if it is to gain an *entrée* into the iron foundry. The present discussion will compare the two furnaces in their chief aspects, developing the proposition, that along certain lines the electric furnace is an admirable adjunct to the cupola whose field of usefulness it materially widens. An increase in the number of electric furnaces in foundries need not necessarily mark a decline in the number of cupolas.

No attempt will be made here to describe any of the many current types of furnaces, but rather to treat the subject from the standpoint of process and product. The arc type of furnace is presupposed. Furthermore, the discussion will be limited to the basic process in contradistinction to the acid, although there is recognised the usefulness, mainly for superheating, of the latter. The basic process is so much more flexible, its chemical possibilities so much greater, and, in general, its potentiality in many practical directions so superior, that it is by far the more interesting and valuable.

Preheating, melting, refining, and superheating are, generally speaking, the four major periods of a complete furnace operation, and they shall serve as the outline to this discussion.

Preheating and melting are accomplished in the cupola so admirably that for simple performance of these duties the cupola is without peer. Its thermal efficiency of probably 40 per cent. looms up impressively in comparison with the probable 12 per cent. of the reverberatory or air furnace, and the 25 per cent. of the reverberatory furnace of the regenerative type. The efficiency of the electric furnace is placed at 60 to 85 per cent. With the comparatively high efficiency of the cupola, however, there is combined a simplicity and cheapness of operation that makes it still what probably it always will be—the best and overwhelmingly the most popular furnace for melting cast iron. Occasionally the electric furnace is used for melting cast iron, but the practice is rare and limited to small tonnages of small or intricate castings, automobile piston rings being a typical example. It is almost impossible for the electric furnace to compete with the cupola for simple melting.

It seems established therefore that for all except rare instances the cupola is the best and most economical furnace for melting, and for such its retention should be sought assiduously. One ton of coke properly charged in the cupola will melt as much grey iron as not less than 4,000 kilowatt-hours of electricity in the electric furnace. The cupola cannot well be spared from the iron foundry, and in preserving it we help to create the duplexing process wherein it plays a rôle so important that we can declare that the cupola makes the electric furnace economically possible for cast iron under certain circumstances.

There probably are many foundrymen, experts at handling the cupola, who will dispute any claim that the cupola is a faulty superheater. That the cupola can superheat must be granted, but usually it is to so limited a degree that superheating is not one of its outstanding features. There is good authority for assuming that the temperature at the hottest part of the melting zone is about 2,200 deg. C., but the iron, once fluid, has but a few seconds in which to acquire additional heat before being hurried down through the bed-charge of coke away from the hot zone; terrestrial gravitation is the restraining power to the effective operation of the cupola as a superheating furnace.

Nevertheless, we must agree that frequently and consistently really hot iron is obtained in the cupola through a combination of correct charging and operation, good coke, sufficient but not excessive air blast, and suitable pig-iron and scrap. There is reason to believe that grey irons with high melting point—those containing very little combined carbon (iron carbide)—are capable of reaching higher temperatures in the cupola than dead-white irons with a high content of combined carbon. Both probably solidify at about 1,150 deg. C., but melt at widely separated temperatures, *i.e.*, about 1,232 deg. or higher for grey irons and 1,150 deg. or less for white irons with nearly all their carbon combined.

Grey iron with only traces of combined carbon will hardly melt at lower temperatures than 1,232 deg. C. It might melt at well over 1,370 deg. C. were it not for the fact that during the preheating period it dissolves considerable carbon, thereby automatically decreasing its melting point. Usually it is between 1,232 and 1,260 deg. C. that the gradually descending melting point meets the

* Paper read before the Institution of British Foundrymen's Annual Conference, Blackpool, September 14, 15, 16, 1921.

† "Improving the Quality of Grey Iron by the Electric Furnace." Transactions of the American Electro-Chemical Society, 35, 175 181. "The Electric Furnace as an Adjunct to the Cupola." Transactions of the American Foundrymen's Association, 28, 352-361.

ascending temperature causing complete fusion of the iron. There is evidence to indicate that speeding up the heating may cause the temperature to meet the falling melting point further up the scale, causing fusion at a higher temperature.

Since its solidifying temperature is about 83 deg. lower than its fusing temperature, a grey iron may be said to start on its molten career with that amount of inherited, quasi superheat. This is a distinct advantage over a dead-white iron, which at the time of fusion has practically none of this seeming superheat. If therefore we assume that a grey iron after melting at 1,232 deg. C. has a seeming superheat of 83 deg. above the freezing point, and if we compare this with temperatures at which such iron is finally tapped from the cupola, we can estimate with fair accuracy the real and the seeming superheating capability of the cupola.

It happens that the Author has a number of temperature records for molten iron from many sources. These all were made with an improved optical pyrometer of the disappearing-filament type. The apparent temperatures were determined by sighting the instrument upon the stream from cupola or ladle and changing to true temperatures by applying the proper emissivity correction.

A study of these records discloses that in various foundries the temperature of grey iron flowing from the tap-hole of the cupola may range from 1,315 to 1,463 degs. cent. Cupola practice, therefore can be divided into three classes according to the prevailing temperature of the iron produced, the classes being as follows:—

Excellent:—Cupola practice producing iron at 1,426 degs. cent. and over.

Ordinary:—Cupola practice producing iron at 1,385 to 1,426 degrees.

Poor:—Cupola practice producing iron at temperatures below 1,385 degrees.

Accepting 1,385 and 1,150 degrees respectively as the approximate melting and freezing temperatures of grey iron, it may be declared from these records that cupolas are superheating grey iron about 83 to 233 degrees above the melting point, or 166 to 316 degrees above the solidifying point, with 236 to 277 degrees above solidification representing the common run of foundries.

An inquiry into the losses of temperature previous to casting produces interesting results. Referring again to our records, we find that the losses given in the following paragraph are fair averages, although it must be clearly understood that the loss of temperature for any of the outlined conditions varies widely under the influence of such variables as volume of the molten stream, size of ladle, temperature of ladle, lapse of time, etc.

Iron flowing down a four-foot cupola spout loses about 14 degs. C. There is an average difference of 38 degrees between the stream of iron flowing into a 5,000-pound reservoir ladle, located at the cupola, and the stream flowing from it. If the iron be poured from ladle to ladle, generally to successively smaller ones, the temperature loss for each transfer is from 38 to 55 degrees. The first mould from a 1,000-pound ladle, filled directly at the cupola, is poured at an average of 55 degrees below the temperature of the iron emerging from the cupola, while the last mould (referring to small or medium size castings) is poured after a loss of 111 degrees. If there was an intermediate transfer from ladle to ladle, the maximum loss represented in the pouring of the last mould may be as much as 165 degrees.

Analysing the whole mass of our data, only a very small bit of which we have displayed here, we find that molten grey iron may drop from 55 to 165 degs. cent. in the time between leaving the cupola and entering the mould. Subtracting these losses from the minimum and maximum temperatures given in a foregoing paragraph, it is found that the final temperature at the mould may range from 1,150 degrees, virtually the freezing point, to 1,410 degrees, depending upon the initial temperature and the method of handling the molten metal. The available surplus above freezing, therefore, may range from nil to 261 degrees.

Excepting the maxima, the surpluses are not impressive in the light of the journey that lies ahead in the mould itself. This journey, perhaps cold, damp, tortuous and long, will absorb the most if not all the remaining superheat. If the iron be of the low-total-carbon, low-phosphorus, low-silicon variety, there is reason to fear for the outcome. Will there be heat and fluidity enough left after filling the mould to hold the risers alive and active during the critical period of solidification?

The duties of molten iron do not end with taking the form of the mould, because there still remains the important work of feeding the new-born casting while solidifying, cooling and contracting. For this, fluidity is the needed property. The most powerful factor for fluidity is superheat. However many other elements have a bearing upon it, among which are the contents of phosphorus, silicon and carbon, the freedom from dissolved iron oxide and entrained slag, and probably factors concerning which as yet our knowledge is very imperfect. Unfortunately the cupola is not always capable of imparting the needed superheat when facing too many adverse influences in the iron itself and unfavourable conditions in the patterns. At such times the cupola requires exactly the auxiliary that is supplied in the electric furnace. Superheating in the electric furnace can be made so powerful that ample fluidity becomes inevitable.

Strong irons are generally notoriously lacking in fluidity, and must either be limited to castings of heavy sections or be heated to a high temperature before being cast into thin sections. The irons of greatest strength contain only a small amount of phosphorus, which element is one of the most powerful aids to fluidity. In grey iron, phosphorus seriously diminishes strength, by forming a low-melting, brittle eutectic of iron phosphide and iron, sometimes called "steadite," that endows the whole casting with some of its brittleness. The role played by phosphorus in cast iron is important, but in the cupola product it has at times the embarrassing effect of rendering fluidity and strength more or less incompatible. None can gainsay that the cupola owes much to phosphorus. Were phosphorus not present in the great run of foundry irons, the cupola would be far from the effective and popular furnace that it is. If strong irons are low in phosphorus their natural fluidity is low, and has to be augmented by raising the casting temperature, which places upon the cupola a burden it can handle only imperfectly. The electric furnace, on the other hand, can superheat even the lowest phosphorus iron sufficiently to make its fluidity equal to the task of running out perfectly, the smallest and thinnest section castings. It throws the whole field of castings open to the so-called non-fluid irons, and should be able to popularise certain exclusive grades of iron.

Not infrequently poor coke is the chief factor in the cupola's failure to superheat. Especially during the war and times of labour shortage and unfest good foundry coke was difficult to obtain, and consequently the quality of many iron castings suffered greatly. On the other hand, the foundries using the electric furnace in series with their cupola were to a great extent immune from the poor-coke pest. It can be declared that any coke capable of melting pig iron or scrap in the cupola sufficiently for it to be transferred to an electric furnace can be used with impunity in the duplexing process, because its shortcomings are set right in the electric furnace. However, it must not be forgotten that good coke is always desirable for the duplexing process, because coke is cheaper than electricity, every extra degree of heat gained in the cupola being money saved in the electric furnace. The electric furnace must not be permitted to set a premium upon bad cupola practice. It overcomes the cupola's deficiencies only at a cost, and after all the best idea of the duplexing process is a perfectly operating cupola delivering its best product for the briefest possible treatment in the electric furnace.

We have seen that the practical temperature limit for grey iron in the cupola is not far above 1,454 degs. cent., while the general average is much lower. However, once the iron is transferred to an electric furnace, progressively higher temperatures become merely a matter of time and electricity, and the foundrymen is left to decide if the expenditure is justified by results. With molten iron delivered to the electric furnace at 1,343 degs., the current necessary to superheat to 1,510 degs. with incidental refining approximates 200 kw.-hours per ton of metal, varying with the size of furnace.

For most purposes the limit for superheating grey iron in the electric furnace may be set at

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1,510 degs., although when needed higher temperatures are readily attained. There is nothing gained by excessive superheating unless it be when a more thorough cleansing of the metal is needed. A temperature of 1,560 degs. in the iron delivered by the electric furnace represents a working margin of about 351 degs. above solidification, and, depending upon the method of handling, gives a surplus ranging from 194 to 305 degs. at the mould. If the iron be poured thus, the moulds may require more refractory sand, and certainly there will be need of better-built moulds than often are made if an undue number of run-outs is not courted. For non-fluid irons and very small castings or castings with thin sections this working margin is of inestimable value.

The subject of hot iron can hardly be dismissed without reference to liquid contraction, which name was given by Longmuir to the local contraction that occurs in the heavier parts of a casting immediately subsequent to the solidification of the outer surface. The relation of this phenomenon to casting temperature is most intimate, and several investigators, among whom is Hailstone,* have demonstrated that grey iron, cast at temperatures in the vicinity of 1,426 deg. Cent. has every chance of being solid, of close grain and maximum strength; cast at medium temperatures, about 1,343 deg., the grain is more open and the strength less; while cast at about 1,300 deg. and lower, blow-holes appear and liquid contraction cavities are common. If this work be accepted, it places the avoidance of liquid contraction within the province of electric-furnace iron, since casting at 1,416 deg. will often mean a metal temperature at the furnace of 1,482 deg. or over.

The peculiarly interesting feature of the basic-hearth electric furnace is its refining power. This operation is almost unheard of in the average ironfoundry, where at times a simple process of mixing, and consequent dilution of impurities, may be said to take its place. In some high foundry circles the idea of refining is not so much overlooked as religiously avoided. When first proposed, the idea of refining in the electric furnace was tersely rejected by several eminent foundry men with the comment that one is not looking for refining operations in the ironfoundry, because refining means oxidation. Their complete conversion was immediate, however, when it was made clear that refining in the electric furnace means deoxidation and not oxidation.

At all events, the cupola is not a refining furnace, whereas the electric furnace with basic lining emphatically is. This furnace, with its unlimited capability for the production of heat, its reducing atmosphere, its reducing and intensely reactive slag, and its ready adaptability, is the refining furnace *par excellence*. For refining, it is the opposite of the cupola and the most potent of all furnaces.

The important characteristics of refining in the basic-hearth electric furnace are :—

It is strongly reducing.
It is degasifying to an appreciable extent.
It is cleansing of entrained slags and oxides.
It is intensely desulphurising.

There are metallurgists who insist that oxygen can be a very beneficial element in cast iron, but the writer is not among those who subscribe to the extreme theories of this group. It is probable that oxygen strengthens iron by assisting the retention of carbon in the combined form, but we fear this is at too great cost and that the gain is problematic. Oxidised iron is the natural product of a badly performing cupola, and is readily recognised by its treacherous lack of fluidity in spite of apparently high temperature. Oxygen seems to raise the solidifying point of iron, making it sluggish and producing castings of unreliable mechanical properties. While such iron itself may be strong, its castings are liable to be openly or internally defective through flaws born of non-fluid metal.

The importance of the question of oxygen in cast iron cannot be over-estimated, but at present metallurgists and foundrymen are sadly handicapped in their investigations by the lack of ready and reliable means of determining the full amount of oxygen. There is no analytical way open by which one can study completely the oxidation of iron or uncover the mysteries shrouding the mechanism of the methods that are used for its deoxidation. There is reason to believe that oxygen can be present in iron in three conditions, namely, (a) mechanically enclosed gases such as CO_2 and CO, (b) gases in solid solution, and (c) oxides of iron, manganese, silicon, etc. The only means for determining oxygen in iron that seems to be in practical operation is the admittedly imperfect Ledebur method, which reaches only the lower oxides of iron, the CO_2 anl a part of the CO, missing completely the oxides of manganese, silicon, and titanium.* Analyses for Ledebur oxygen in grey iron from both stages of the duplexing process indicate that such oxygen is reduced by the electric-furnace stage of the process to from one-sixth to one-third of what it was upon leaving the cupola. Visibly this change manifests itself by increased fluidity, an iron low in iron oxide being more fluid than one high in oxide with temperatures the same. Therefore the basic electric furnace is seen to have a two-fold influence for increased fluidity, namely, by raising the temperature and by decreasing the oxide.

Of the effect of the electric furnace upon the other gaseous constituents of cast iron nothing is known except upon nitrogen, concerning which the writer has some scant analytical data. Like oxygen, this element probably exists in several forms in cast iron. The only form that seems to be within reach of the analytical chemists is combined nitrogen, probably nitride, which responds to analysis by the Allen method. The nitrogen as determined by this method in a number of samples of grey iron melted in the usual way in the cupola, ran from 0.008 to 0.012 per cent., whereas after refining the same irons for about thirty minutes in the basic electric furnace, it was found to be from 0.004 to 0.006 per cent.

There is no doubt that from the viewpoint of economy the most interesting feature of refining in the basic electric furnace is desulphurisation. With the bath of sulphur-bearing iron at a high temperature resting upon a bottom of magnesite or dolomite, under a chemically active blanket of calcareous slag, the transfer of sulphur from iron to slag is facile, rapid, and certain. Given the proper conditions in furnace and slag, none of which is difficult to attain, the diminution of sulphur is merely a question of a short time. The following is illustrative of the progress of desulphurisation in an iron fairly rich in sulphur :—

0.156	per cent. ...	As received from cupola.
0.133	,, ...	10 minutes
0.112	,, ...	20 ,,
0.079	,, ...	30 ,,
0.036	,, ...	40 ,,
0.031	,, ...	50 ,,
0.014	,, ...	64 ,,

In this case but one slag was used. The heat was continued further than commercially necessary, and for practical purposes could have ended after 30 minutes.

The chemical reaction by which sulphur is removed in the basic-hearth electric furnace is as follows :—

$$FeS + CaO + C = Fe + CaS + CO; \text{ or}$$
$$MnS + CaO + C = Mn + CaS + CO.$$

That the full reaction is more complex than here indicated is probable, although its essential outline is as given. Its significant feature is that sulphur is taken from the iron as insoluble calcium sulphide, which, however, is soluble in the slag. The key to the reaction is the fact that desulphurisation is impossible except with deoxidation, the two going hand in hand. The deoxidising condition is readily obtained by enriching the slag in carbon through the addition of coke dust. Combining with lime the carbon forms of calcium carbide which is the necessary agent for the required degree of deoxidation in the metal. Calcium carbide is made possible by the high temperature of the electric furnace. Were the conditions oxidising, the calcium sulphide would be oxidised to sulphate, which would react with the iron to form iron sulphide once more, and as such the sulphur

* In Carnegie Scholarship Memoirs, published by the Iron and Steel Institute, London, in 1913 and 1914

* J. R. Cain and E. Pettijohn : "A Critical Study of the Ledebur Method of Determining Oxygen in Steel." U.S. Bureau of Standards, Technical Paper 118 (1919).

would re-enter the bath. Here is a refining reaction that is thoroughly deoxidising, and therefore incapable of harm to the metal.

This ready method of ridding cast iron of the most of its sulphur is of vast and growing importance in current times. The accumulation of sulphur in the world's scrap-heap is becoming a problem. Every remelting increases its sulphur, and metallurgists foresee a time when the heaped-up sulphur will be a veritable menace. Much poor, high-sulphur coke was used in foundries during the war, and eventually all this sulphur will find its way back to the foundry contained in scrap. Those who use a large proportion of pig-iron in their mixtures say there is no sulphur problem for them, but transportation charges universally are becoming so high that some of these, for financial reasons, may be forced sooner or later either to move nearer to the source of their iron supply or to make use of the scrap near at hand, which last condition means that they then must face the sulphur problem. Also they may come to the use of more scrap on the ground that it is an economic duty for every foundry to use a just share of the world's huge scrap pile. At all events, in the world of cast iron the accretion of sulphur is a menace that looms up in the near future.

The question arises as to how far desulphurisation should be carried. The greatest reduction of 0.100 per cent. to about 0.070 per cent. Such reduction simply means the making safe and useful irons that are otherwise openly dangerous on account of their hoard of sulphur.

An indirect benefit from reduced sulphur is a saving of manganese. This element has two purposes in iron—to deoxidise, and to minimise the evil effects of sulphur. One part by weight of sulphur is taken in charge by about 1.7 parts of manganese, to form 2.7 parts of manganese sulphide, the advantage of the reaction being that it takes place to the exclusion of iron sulphide. The excess of manganese from this reaction helps form the double carbide of iron and manganese. It is well known that manganese carbide is harder than iron carbide, and the hardness of iron castings, especially small ones, is thereby considerably influenced. Therefore a reduction in sulphur may result in an increase in manganese carbide with a parallel increase of hardness.

To consider this situation more mathematically let us assume a grey iron with 0.80 per cent. manganese and 0.130 per cent. sulphur. This amount of sulphur requires 0.22 per cent. manganese, forming 0.35 per cent. manganese sulphide, while the remaining 0.58 per cent. manganese unites with carbon to form manganese carbide. If the sulphur in this iron be reduced to 0.050 per cent. there is needed only 0.085 per cent. manganese to account for it, and the amount left free to form carbide is

TABLE I *showing the Increase in Transverse Strength after the Electric Furnace Treatment.*

Heat No.		Carbon.	Silicon.	Manganese.	Phosphorus	Sulphur.	Transverse strength in cwts.
1221 ..	Cupola ..	3.48	1.92	0.56	0.53	0.099	25.1
	E.F. ..	3.38	1·82	0.61	0.51	0.022	36.7
1281 ..	Cupola ..	3.50	1.79	0.54	0.62	0.158	24.7
	E.F. ..	3.22*	1.94†	0.54	0.61	0.052	35.5
6271 ..	Cupola ..	3.35	1.91	0.72	0.59	0.091	33.4
	E.F. ..	3.26	1.77	0.73	0.58	0.018	45.5
1721 ..	Cupola ..	3.40	1.94	0.42	0.58	0.069	32.1
	E.F. ..	3.41	2.21†	0.44	0.56	0.026	37.6
8172 ..	Cupola ..	2.90	1.54	0.43	0.54	0.151	—
	E.F. ..	2.91	2.28†	0.51‡	0.55	0.013	37.5
8182 ..	Cupola ..	2.77	0.89	0.24	0.44	0.160	—
	E.F. ..	2.69	2.18†	0.52‡	0.40	0.057	45.6
3419 ..	Cupola ..	3.39	2.16	0.77	0.62	0.057	25.1
	E.F. ..	3.14**	1.90	0.84	0.55**	0.019	34.1
2221 ..	Cupola ..	3.45	1.83	.0.34	0.48	0.112	29·5
	E.F. ..	3.38	2.30†	0.36	0.47	0.033	35.8
1191	E.F.only	2.94	1.52	0.62	0.27	0.009	37.0

* Carbon reduced by mill scale in electric furnace. † Ferro silicon added in electric furnace. ‡ Ferro-manganese added in electric furnace. ** Carbon and phosphorus reduced by dilution with steel.

sulphur in grey iron made by the Author was from 0.171 in the cupola melt to 0.013 per cent. in the same iron refined in an electric furnace, with a single slag in eighty minutes. The lowest sulphur attained was 0.009 per cent. in some steam-valve castings that probably are the lowest-sulphur grey-iron castings ever made. This extremely low sulphur is reached only by the expenditure of much time and electricity, and, moreover, is not recommended to the average foundry at present, nor until our knowledge of the benefits of extremely low-sulphur iron has expanded beyond its present confines. An iron casting with 0.030 per cent. sulphur contains about 0.081 per cent. by weight of structurally free sulphide. If the sulphur be doubled the amount of sulphide still is inconsequential, and we doubt if the difference between these two sulphur contents can be measured in the mechanical properties of the castings. However, increase the sulphur to 0.100 per cent. or over, and the resulting 0.27 per cent. or more sulphide becomes a sinister factor to be reckoned with.

Our opinion is that if the sulphur is below 0.070 per cent. it cannot be considered dangerous in any ordinary grey-iron casting; above that segregation is liable to occur with harmful results. Sulphurs of 0.050 per cent. and under are needed for only unusual conditions, and any advantage claimed for them is largely speculative. In the average foundry practical desulphurisation will consist in reducing sulphurs that originally are well over increased to 0.715 per cent. This reduction of sulphur therefore directly causes an increase of nearly one-fourth in the amount of manganese carbide in the iron. Quite probably this change would not be noticed in the hardness of fairly large castings, but there is ample experience indicating that in small castings it is liable to become embarrassingly noticeable.

In the case of sulphur reduction assumed in the foregoing paragraph the amount of manganese carbide can be kept at its original figure by making the manganese correspondingly lower to agree with the reduced sulphur. That is, a manganese content of 0.665 per cent. will with 0.050 per cent. sulphur give the same amount of manganese carbide as 0.80 per cent. does with 0.130 per cent. sulphur. In practice this condition is taken care of by using lower manganese irons to begin with whenever electric furnace refining is to follow the cupola operation. This lowering of manganese is accompanied often by definite economic advantages in the purchase of raw materials.

The fact is the electric furnace conserves manganese in several ways, and lower manganese specifications become compatible with good castings. In the electric furnace all the harmful effects of oxidation in the cupola are wiped away, making unnecessary as much manganese as formerly was needed. Excellent grey iron has been made by this process with much less than the 0.50 per cent. manganese that has long been considered the lowest

safe limit. Another benefit of the deoxidising influence of the electric furnace is the absolute immunity of the manganese from loss during the iron's stay in the furnace.

Considering some of the other elements in cast iron, we find that carbon may be reduced or increased at will. Ordinarily in an electric furnace free from rusted material it remains unchanged. Reduction of carbon is possible in two ways, by dilution with steel added in the electric furnace, which should be the preferred method, and by the addition of predetermined but never very great amounts of iron ore or scale, removing some of the carbon by oxidation. This last operation is familiar to steel makers, but for grey iron should be resorted to with caution. Dilution with steel especially furnishes an attractive method for the production of so-called semi-steel of a quality and uniformity not possible by the old method in the cupola.

The element phosphorus in grey iron is not affected in the basic electric furnace. This is contrary to the belief of many who are more familiar with the dephosphorisation of steel. Before grey iron could be dephosphorised, the bath would have to be reduced in carbon and silicon until it became a veritable steel; then by oxidation and removal of the slag the phosphorus could be removed, after which the carbon and silicon would have to be restored. Plainly, dephosphorisation of grey iron in the electric furnace is not economically possible. Like carbon, however, it can be reduced to a limited extent by dilution with steel.

Silicon in grey iron may be varied at will to suit the size and nature of the castings. It is controlled in the cupola phase in the usual way, and by making additions of ferro-silicon in the electric furnace.

The table on the previous page gives at a glance the results obtained by duplexing several lots of grey iron. The last heat on the list is an exception, being a heat of scrap metal that was melted from a cold charge in the electric furnace. Analyses and transverse strengths are given of the irons before and after going through the electric-furnace phase of the process. The transverse tests were made with the "arbitration bar" that is standard in the United States, the bar being 1¼ in. in diameter, 15 in. long, and tested upon supports 12 in. apart. The interesting fact about the test is that the duplexed iron is uniformly stronger than the cupola iron, the average increase being about 33 per cent. Another interesting fact typical of a great number of heats is shown in heat 2221, where a substantial addition of silicon made in the electric furnace was accompanied by an increase in strength that would be entirely unlooked for under ordinary conditions on account of the expected effect upon the combined carbon in the casting.

The cost of the electric furnace duplexing process for cast iron is difficult to discuss because there are many important factors that are extremely variable. Among these are size of furnace, cost of current, intensity of operation, degrees of superheating, and extent of refining necessary, and care and skill in operation. In the United States duplexing is being done at costs varying from six dollars to fifteen dollars per ton above the cost of ordinary cupola iron. Whether or not this added cost is prohibitive depends upon the nature of the castings.

It is hardly necessary to say that for ordinary castings made upon a strictly competitive basis the duplexing process cannot compete with or displace the cupola process. However, its use is feasible for extraordinary castings; for example, those requiring unusual physical properties such as tenacity, solidity and most rigid freedom from all kinds of flaws. Its use is feasible for making out of strong but highly non-fluid irons, castings that normally would be impossible for such irons. It also is economical for castings that are extremely expensive in every step of their production, as also it is for castings that, although by nature liable to defects, are not discovered to be defective until after much costly machine work has been expended upon them. In short, the duplex process is eligible wherever high quality or strong insurance against defective castings is desired. The time is not yet at hand to recommend the electric furnace for ordinary castings under ordinary conditions, but only to suggest it as a highly efficient adjunct to the cupola for extraordinary castings and circumstances.

Before closing we must sound the warning that the electric furnace is not a cure-all for the many ailments to which the iron foundry is heir. Its adoption is not a surcease from all care, for if not attended by experienced and intelligent metallurgical supervision, it can readily become the source of the greatest worry and disappointment. Efficient and versatile as the electric furnace may be, it still is comparable to a highly developed machine that can be placed with assurance only in the hands of trained and intelligent operators. It needs the help of sound metallurgical sense, well directed thought and study, and at times even of constructive imagination.

In closing, the writer makes pleasurable acknowledgment of an indebtedness to his friend and associate Mr. S. J. Felton, whose suggestions, especially concerning the temperatures of molten iron, were extremely helpful.

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Air-Driven Wire Brush for Metal Cleaning.

Wire-brush cleaning of metal surfaces offers an opportunity for considerable saving of time and labour. It has been difficult, however, to obtain a wire brush of proper design and materials, which would work effectively on an air motor and not wear out too rapidly.

A wire brush of very rugged design, described in a recent issue of the "Compressed Air Magazine," has recently been placed on the market by the Ingersoll-Rand Company, 11, Broadway, New York, for use with its standard No. 6 "Little David" drill. The brush has a face diameter of 5 in., and is made up of wires of a special heat-

FIG. 1.—DRILL WITH WIRE BRUSH ATTACHED.

treated steel which has been found to have very good wearing qualities. It is sturdily constructed and will stand up under severe service.

The brush is manufactured particularly as an attachment for the No. 6 drill (as illustrated), this type of machine being especially suited for work of this nature. The drill has liberal bearings to take up all the end thrust when pressing down on the work; a high speed and very reliable motor, and moreover is of light weight and small overall dimensions. It can be used in sharp corners and other cramped spaces.

The wire brush outfit is adapted for removing paint, rust, scale and dirt from tanks, steel cars, structural steel and all sheet metal surfaces, and altogether weighs only 11½ lbs. It is very useful for cleaning iron, steel and aluminium castings.

Fluorspar in U.S.A., 1920.—The total quantity of fluorspar delivered from domestic mines in 1920, according to figures compiled by the United States Geological Survey, was 186,778 net tons (2,000 lbs.), valued at $4,718,547, an increase of 35 per cent. in quantity and 34 per cent. in value as compared with the previous year. The general average price per ton f.o.t. mines for all grades of spar in 1920 was $25.26, compared with $25.49 in 1919. Imports of fluorspar in 1920 amounted to 24,612 net tons, valued at $265,630, an increase over 1919 of 254 per cent. in quantity and of 147 per cent. in value. The exports of fluorspar in 1920, all of which went to Canada, amounted to 2,764 net tons, valued at $65,475. Figures furnished by steel manufacturers who produce about 75 per cent. of the output of basic open-hearth steel show that the industry consumed about 117,000 net tons of fluorspar in 1920.

Trade Talk.

THE shipbuilding yard of Robert Thompson & Sons, Limited, Southwick, Sunderland, has been re-opened this week.

A. W. SAINSBURY, LIMITED, engineers, have removed from 89, Arundel Street, Sheffield, to Sainsbury's Buildings, Campo Lane, Sheffield.

STUBBING EDGE HALL has been acquired by the Sheffield Works Convalescent Association as a recuperative centre for Sheffield workers in the steel and associated industries.

THE L.B.H. brand of rough copper, produced by MM. Lemoine-Bies-Harang, Paris, has now been placed on the London Metal Exchange official list of standard brands.

LICENCES HAVE been granted under the Non-Ferrous Metal Industry Act, 1918, to D. A. Daniels, London, and A. Towell, trading as the Provincial Metal Company, Birmingham.

CONSIDERABLE damage has been done by a fire which broke out on the premises of H. D. Evans' Iron Foundries, Collingdon Road, Cardiff. The pattern shop was practically destroyed.

BETWEEN THE RIVERS Abid and Oumerrebia prospectors report the discovery of a layer of magnetic iron, estimated to amount to 100 million tons, which can be exploited near the surface by hydro-electric power from waterfalls near Abid.

AMONGST the local authorities who have recently taken delivery of Karrier street scrapers are those of Manchester and Rotterdam. A large order for Karrier lorries received from the London and South-Western Railway Company has just been completed.

BOTH BELGIAN AND GERMAN competition in close annealed steel sheets have, states the Eastern Export Company in its weekly report, been more or less eliminated for the present. Most of the business is stated to have returned to the United Kingdom works.

MOLYBDENITE, tungsten, manganese, vanadium, and other metals obtainable in Australia are now being locally used in the manufacture of high-grade steels. One large English firm has commenced operations in two States, and there are prospects of important extensions.

THE LARGEST CONSIGNMENT of tinplates and galvanised sheets which has left Swansea for 12 months was cleared from Swansea Docks this week, consisting of 9,000 tons, for Singapore, Shanghai, and other Chinese ports. The value represented is about £200,000.

THE RAILWAYS COMMISSIONERS of the State of Victoria, Australia, have strongly advocated the erection of a thoroughly modern coal-handling plant at Melbourne, for which it is understood that a site will be selected near the Victoria Dock. The estimate of the cost is £150,000.

THE CUNARD COMPANY has ordered the resumption of work on three of its five liners building on the Tyne. Two are already in the water, having been launched from Swan Hunter's yard, Wallsend, and Armstrong, Whitworth's yard, at Walker. The third is building at Hawthorn Leslie's yard, Hebburn.

AN ENCOURAGING FEATURE of business in Canada at present is the steel industry. It is reported that two of the largest steel plants in Canada are working on Government orders, which will keep them busy for some months, and that the large steel plants are running about 70 per cent. of last year's capacity.

MR. JAMES R. PRESTON, technical manager of the shipbuilding branch of the Fuller Construction Company of the United States of America, during a recent interview, asserted that the shipbuilding industry out there was dead so far as freighters are concerned, and said practically the only vessels now being constructed were oil tankers.

THE TYNE FIRMS tendering for the new battleships are the Armstrong, Whitworth Company, and Swan, Hunter, and Wigham-Richardson, Limited, with Hawthorn, Leslie & Company, and the Wallsend Slipway and Engineering Company interested in the engines. The Armstrong, Whitworth Company are also prepared to provide armament.

FOR THE RECENTLY ANNOUNCED resumption of work at Port Pirie, plant capable of treating from 2,000 to 3,000 tons per week has been prepared. The former Dwight Lloyd roasting plant had a capacity of 5,000 tons per week. The present plant is only temporary, and has been erected in consequence of the decreased production of ore-concentrates.

"THE ESTIMATED aggregate duration of all the 477 disputes reported during the first eight months of the present year was approximately 84,000,000 working days," states the "Labour Gazette." During this period the weekly wages of 6,000,000 workpeople were reduced by more than £3,550,000, while there was an increase of £73,000 in the wages of 320,000.

A GENERAL MEETING of the Institution of Production Engineers will be held on Saturday, September 17, at the Institution of Mechanical Engineers, Storey's Gate, London, S.W., when Mr. J. D. Scaife, member of council, and works manager of the Ransome & Marles Bearing Company, Limited, Newark-on-Trent, will read a paper on "The Manufacture of Ball and Roller Bearings."

THE PREMISES lately occupied by the Road Club, now in possession of the Engineers' Club, should be adequate, for some time at any rate, to the needs of the organisation. With 77 bedrooms, dining-rooms to seat over 1,000, and a billiard-room with five tables, it should prove a decided acquisition, as it provides a convenient centre where sections of engineers can meet socially.

THE WORLD'S PRODUCTION of aluminium has increased nearly three-fold during the past eight years. The following figures are given in the "Agence Rhenane" for 1920, with the 1913 output in parentheses, both years in metric tons:—Germany, 40,000 (1,000); Austria and Switzerland, 25,000 (11,000); France, 20,000 (18,000); Great Britain, 12,000 (7,500); Italy, 7,000 (1,000); Norway, 16,000 (1,600); United States, 73,000 (28,000); total, 193,000 (68,000).

ARMSTRONG, WHITWORTH & COMPANY have obtained the contract for the conversion of the Cunard liner "Berengaria" from coal burning to oil-fuel burning. This enormous vessel, formerly the Hamburg-Amerika "Imperator," is the third largest ship in the world, being 882½ ft. long, 98¼ ft. beam, and 57 ft. depth. The contract will be carried out at the Armstrong Yard Newcastle-on-Tyne.

A COMPLETE lock-out of boiler makers is threatened in the Mersey ship-repairing yards owing to the action of the emloyers in cancelling the agreement by which twenty-five men were employed on any job where an oxy-acetylene burner is used. The men say they are willing to discuss the question if the notice terminating the agreement is withdrawn, but the employers refuse to withdraw the notice.

AN arbitration recently took place at the Industrial Court, London, between the Welsh Founders' Association and their employés, the West Wales Allied Trades Committee. The court was presided over by Mr. McLeod, Mr. Bryce, and Mr. Cummings. The owners ask for a reduction of 15s. a week in the case of tradesmen, and a pro rata reduction for labourers. The arbitrators will give their award later.

THERE HAS BEEN FORMED in the United States an organisation to stimulate by co-operative effort the use of copper, brass, and copper alloy products. The new organisation, entitled "The Copper and Brass Research Association," has at its head Mr. R. L. Aggassiz, president of the Calumet and Hecla Mining Company and of the United States Copper Export Association.

RESULTS of the Bombay Corporation's invitation for tenders for the construction of pipe lines estimated to cost some two to three million sterling are welcomed as showing that British industry can still stand on its own merits. The work in question comprises the supplying and laying of 42 miles of 72-inch mains and 63 miles of 57-inch mains. Of the eleven tenders put in Messrs. Braithwaite & Company, of Calcutta, who offered English steel, and are backed by a well-known English firm, made the lowest offer, amounting to 256 lakhs (some 2½ millions sterling, nominal).

ACCORDING to present plans, a specially-designed exhibition ship, under the title of "British Industry," will set sail from the Thames in the summer of 1923, for the chief ports of the world. The scheme is promoted by the British Trade Ship, Limited, with registered offices at 12, Grosvenor Gardens, S.W.1, and a board assembled under the chairmanship of Earl Grey. The board of the British Trade Ship, Limited, consists of Earl Grey (chairman), Sir Geo. B. Hunter, K.B.E. (vice-chairman), Commander Roderick W. Day, O.B.E., R.N.R., Major G. P. Denton, M.C., Sir Maxwell Hicks, C.B.E., Mr. Edmund M. Hill, M.I.Mech.E., M.I.E.E., the Duke of Northumberland, Mr. J. W. Beaumont Pease, J.P., Mr. Noel E. Peck, and Mr. T. E. Thirlaway.

AT the annual meeting of the Central Board of the Shipbuilding Employers' Federation held in Carlisle on Friday last, Mr. James Lithgow, of Lithgows, Limited, Port Glasgow, was elected president of the Federation in place of Sir Alexander M. Kennedy, of the Northumberland Shipbuilding Company, Limited, and Fairfield Shipbuilding and Engineering Company, Limited. Mr. Leonard Ropner, of the Ropner Shipbuilding and Repairing Company (Stockton), Limited, Stockton-on-Tees, now becomes senior vice-president, and the position of junior vice-president was filled by the election of Mr. Grant Barclay, of the Caledon Shipbuilding and Engineering Company, Limited, Dundee, who is one of the few surviving members of the original Board of the Federation when it was formed in 1899.

XUM

IRON AND STEEL MARKETS.

Pig-iron.

Confidence in a returning activity in the pig-iron trade may be assumed from the necessarily slow but steady increase in the number of furnaces in action, which, although mainly employed in supplying their owners' requirements for steel production, indicate a welcome change from the idle conditions so long prevailing in the iron smelting industry. Improvement in this direction is, however, so inseparably dependent on a readjustment of costs of production, viz., graduated reductions in wages and prices of fuel and raw material, that it is difficult to forecast how soon this much desired result can be achieved. Ironmasters confronted with this problem cannot restart blast furnaces until coke, limestone and ore are obtainable on cheaper terms, and while both coal and quarry owners are resolute in declining further concessions there is little possibility of expanded production until these conflicting interests can be reconciled. In South Staffordshire little more movement is observable in pig-iron. Here and there preparations are being made for restarting furnaces. Demand, however, is so small that there is no justification at the moment for a general resumption. The foundries, as a result of the slump in shipbuilding and depression in general engineering, are badly in want of orders. Last week Midland pig-iron smelters intimated that associated terms were abandoned, and they invited offers. Makers quoted Derbyshire No. 3 foundry £7 to £7 5s. delivered, and Northampton £6 10s. per ton. On this basis Derbyshire forge became £6 10s. and Northampton £6 per ton. In the West of Scotland there is no improvement to report in the pig-iron market, and the expectations cherished in many quarters that the autumn would see a decided change for the better do not yet show signs of being realised. Buying generally is conducted on a hand-to-mouth basis, and nobody seems to have confidence to buy more than is absolutely necessary to keep their works moving. The Cleveland iron market continues dull, but there is so little No. 3 Cleveland G.M.B. that no difficulty is experienced in maintaining the price at 125s. for prompt lots. Only very small quantities are changing hands, and if and when there is any substantial expansion of output it might be difficult to find a market even at the official price of 120s. All the other qualities are freely offered at the prices which were fixed some months ago as the Cleveland minimum scale, viz., 119s. for No. 4 foundry, 117s. 6d. for No. 4 forge and mottled, 115s. for white iron. The demand, however, is very limited, as most of the foundries are very slack and some are altogether idle. Foreign trade, too, is dead, as our prices are too high to compete with those of Continental producers.

The East Coast hematite trade shows signs of recovery from the recent depression, and it is anticipated that two more blast furnaces will be blown in this week, making a total of nine furnaces producing hematite on Tees-side. The demand is still only limited, but makers seem to be able to market their output at 140s. per ton, although it is stated that 135s. would be accepted for an export order. Early in the current week the Barrow Hematite Steel Company, Limited, restarted one of their furnaces, and with an improved outlook in the West Cumberland ore industry others are expected to be working shortly.

Finished Iron.

With the near approach of the end of the current quarter more interest is apparent in the finished iron section of the markets, and although it would be idle to pretend that any actual improvement in business has so far resulted, the growing volume of inquiries gives encouragement to the hope of better times ahead. The tendency to reduced costs of production now in progress will, at all events, place the home manufacturer of finished material on a more equitable basis for meeting outside competition, and with the revival of demand anticipated should bring a welcome change from the present stagnant conditions. In the foundry departments the failure, from financial reasons, of the extensive housing schemes, which are apparently to be postponed, has had an adverse effect upon the industry, thus preventing the placing of orders for large quantities of light iron and steel castings, girders and many other descriptions of builder's ironmongery, while the slackness in the engineering branch is a further factor in the prevailing trade depression. Bar makers in South Staffordshire, as far as concerns marked qualities, continue fairly well employed, but crown and the commoner brands of material seem to have no market demand at all. Quotations for the latter qualities of bars have undergone a change from the previous figures, prices for both Staffordshire and Lancashire crown brands being now £14, makers suggesting that a reduction might mean stimulating the demand. In the West of Scotland finished iron producers report that few orders are being received on home and practically none on export account, and works in the district are being run intermittently and in a hand-to-mouth way. Though the pressure of German competition has relaxed to some extent of late, in view of the activity of the works in that country and the impossibility of promising deliveries earlier than about three months ahead, producers in Belgium are offering very low-priced material, and the fact that their quotations have firmed up a little lately does not lessen the competition from that quarter, as they are still considerably below those quoted by local makers.

Scrap.

The extreme depression in the scrap iron markets continues without any abatement, and holders of stocks, and dealers generally, are far from hopeful of the position. The fact is that scrap can scarcely be sold now, and in the iron trade department of the market practically there is a demand only for good cast scrap iron. Even this demand is slowly lessening, in consequence of the lack of orders for iron castings, which is affecting almost every iron foundry in the country. In South Wales there are only hand-to-mouth dealings. Heavy steel scrap for furnace use is quoted 60s. to 70s.; bundled steel scrap and shearings, 45s. to 65s.; wrought iron and steel scrap for basic furnaces, 20s. to 70s.; heavy cast-iron scrap, £4 5s. to £4 10s.; good foundry and machinery scrap, £6.

Steel.

So far there is little actual improvement to report in the general outlook of the steel industry, though here and there indications are not lacking of a more active tendency in certain branches of the trade. At Sheffield, for instance, the unemployment returns show a steady, if slow, decline in the number of workers, while local steel makers also report numerous good orders in circulation, or already placed in this district. Another important element in stimulating production has been a reduction in electric power charges in Sheffield, which has enabled the owners to restart some of the steel furnaces, while the new Government shipbuilding programme must ultimately provide a large amount of employment for Sheffield industries. Confirmation of a more optimistic outlook in steel trade circles is furnished in a statement by Sir Arthur Dorman, chairman of Messrs. Dorman, Long & Company, who, in a recent interview, said:—"If the cost of coal could be reduced to allow the iron and steel industries to meet foreign competition, even without making any profit, we will start our furnaces at once." Similar views are held also in the Scottish steel trade, chiefly owing to the decline in prices, which are now approaching competitive values. Considerable reductions will still be necessary. Inquiries in the markets indicate plenty of business whenever prices are suitable. All branches of the steel trade are badly in need of orders, and it is discouraging to see so much business being lost to Continental makers. Some very low home quotations for steel plates, sheets and angles have been hinted at, but definite figures cannot be ascertained. It is doubtless true, however, that very favourable terms can be secured for acceptable orders. Last week steel hoops were officially reduced by the Midland Hoop Makers' Association £3 per ton, from £17 to £14; steel wire rods are lower at £12 10s., and certain light descriptions of steel tinned wire were reduced 50s. per ton, from £46 10s. to £44. On Tees-side the steel trade is still very quiet. Home buyers only order for immediate needs, as further reductions are anticipated, and in order to get orders abroad steel makers have to make drastic reductions on the fixed home prices. There seems to be a slight improvement in the shipbuilding industry. Orders are still extremely scarce, but the fact that a few tentative inquiries are being made is regarded as a hopeful sign that trade is on the mend. Both Scotch and English makers have reduced their prices by £2 per ton.

Tinplates.

Business in the tinplate market remains quiet and uneventful, although evidence is forthcoming that confidence is gradually returning, the re-starting of idle mills being generally accepted as an indication of improvement in trade conditions. Inquiries are reported as coming forward more freely, while the Far East has been purchasing small lots of 20 by 14's light weights, wasters, and unassorted plates, and the Continent has taken some crosses. Prices, however, are on the easy side, forward plates having been done at 22s. basis I.C., f.o.b., and prompt at 23s. basis I.C., f.o.b., sellers. Home consumers have taken a few odd sizes at 22s. basis, f.o.b., for forward plates, but at this figure they are not keen. With the exception of 20 by 14's, which have been taken by Japan, wasters are also on the easy side, but C.W., 28 by 20, are rather buyers at 39s., f.o.b., whilst quarter wasters are dull at 16s., f.o.b.

Metals.

Copper.—Stimulated by more favourable American, financial and industrial influences, the market for standard copper has developed a steadier tendency of late, and fluctuations in values, when recorded, have mostly been within fractional compass. Buyers on specu lative account has also been on a more active scale, and although consumptive capacity has not yet expanded to any marked extent, more metal is undoubtedly going into actual use. The week's markets opened with a firm tone on receipt of better American advices, and a small improvement was marked both for prompt and forward metal. October was done at £68 15s. to £68 7s. 6d., November £69, and December £69 5s. to £69. Refined copper with a better inquiry reported was firmer, electrolytic closing unchanged to 10s. advance at £72 10s., with wire bars 5s. to 15s. higher at £73 10s. to £74 10s. Closing prices :—Cash : Wednesday, £67 17s. 6d.; Thursday, £67 12s. 6d.; Friday, £67 15s.; Monday, £68 2s. 6d.; Tuesday, £67 15s. Three Months: Wednesday, £68 17s. 6d.; Thursday, £68 10s.; Friday, £68 12s. 6d.; Monday, £68 17s. 6d.; Tuesday, £68 10s.

Tin.—With one or two exceptions values in the tin market have maintained a remarkably steady level of late, and business has certainly shown a more active tendency, the turnover in the week before last having reached 3,200 tons, a record for the current year. The improvement in the statistical position, showing a decrease for August, has doubtless had a favourable effect upon the speculative section of the market, and has probably been further stimulated by the re-opening of many of the South Wales tinplate mills. In this week's opening market the tone was again steady, and with sellers reserved values further appreciated. September was done at £154 10s. down to £154; October, £155; November, £155 5s.; December, £156 5s. to £156 12s. 6d. There has been also a better export demand for English tin, with ingots closing at £152 to £153. The weekly return of tin stocks in London warehouses at 3,699 tons shows a decrease of 175 tons on the week; Liverpool stocks an increase of eight tons to 1,698, with Swansea stocks ten tons increase at 25 tons. Closing prices :—Cash : Wednesday, £155 15s.; Thursday, £155; Friday, £154 5s.; Monday, £154 7s. 6d.; Tuesday, £155 10s. Three Months: Wednesday, £158; Thursday, £157 5s.; Friday, £156 10s.; Monday, £156 12s. 6d.; Tuesday, £157 15s.

Spelter.—Business in this metal continues quiet, holders maintaining a reserved attitude, but with values firm and slightly improved from the previous quotation. October sold at £25 2s. 6d.; November, £25 7s. 6d.; and December, £25 10s. Closing prices :—Wednesday, £25 5s.; Thursday, £25; Friday, £25; Monday, £25 2s. 6d.; Tuesday, £25.

Lead.—This section of the metal markets continues active, with a fairly good demand for prompt forward dates, soft foreign pigs for October selling at £22 15s.; November, £22 15s.; and January, £22 10s. English closing prices:—Wednesday, £24 5s.; Thursday, £24 5s.; Friday, £24 5s.; Monday, £24; Tuesday, £24.

Deaths.

MR. J. DANIELS, head of the engineering firm of T. H. Daniels & Company, Limited, of Light Pill, Stroud, has died at the age of 81 years. The deceased had been in ailing health for some time past, but until a few days ago he was able to follow his daily routine.

THE death is reported of Mr. William Beardmore, of Ivy Dene, Corporation Road, Newport, head of the wages department at Messrs. Lysaghts' Orb Works, whilst on a visit to Wolverhampton, at the age of 63. He has been in Messrs. Lysaght's employ for 37 years.

SIR THOMAS SALTER PYNE, M.Inst.C.E., M.Inst.M.E., whose death is announced at the age of 61 years, served his time as an engineering apprentice, and went to India at the age of twenty-three. In 1885 he accepted an appointment at Kabul in the service of the Ameer, and for nearly ten years was concerned in the introduction of various industries into Afghanistan.

MR. T. DIAMOND, of Cardiff, died on Friday in his eighty-second year. He was probably the oldest figure at the Cardiff Docks, where he had been engaged for the past fifty-five years in the ship-repairing industry. He served his apprenticeship at Appledore, and after extending his experience for some time at the Pembroke Dockyard, he removed to Cardiff fifty-five years ago, and in 1886 established a business of his own, which is still conducted under the title of Thomas Diamond & Company, engineers and boilermakers.

Company News.

Sir W. G. Armstrong, Whitworth & Company, Limited.—Interim ordinary dividend, 6d. per share, less tax.

British Aluminium Company, Limited. — Ordinary dividend, 5 per cent. per annum, less tax, for six months ended June 30.

Browett, Lindley & Company, Limited.—Interim preference dividend, 6 per cent.; interim ordinary dividend, 4 per cent., less tax.

Atlas Metal & Alloys Company (1921), Limited. — Capital £5,000 in £1 shares. Registered office: 52, Queen Victoria Street, E.C.

Stewarts & Lloyds, Limited.—Interim preference dividend, 6 per cent. per annum; interim preferred ordinary dividend, 10 per cent. per annum.

Pembroke Metals, Limited.—Capital £5,000 in £1 shares. Directors: O. L. Harries and W. R. Howell. Secretary: F. M. Rees. Registered office: Pembroke Buildings, Swansea.

James Walker & Company, Limited. — Capital £250,000 in £1 shares, to carry on the business of engineers, etc. Registered office: Lion Works, Garford Street, Poplar, E.

Scottish Engineering Corporation, Limited.—Capital £10,000 in £1 shares, to take over the business of the Scottish Engineering Corporation. Registered office: 128, Hope Street, Glasgow.

Wm. Murrell & Company, Limited.—Capital £5,000 in £1 shares (3,000 ordinary and 2,000 10 per cent. cumulative preference), to carry on the business of ironfounders. Registered office: 237, Walworth Road, S.E.

Elliott's Metal Company, Limited.—Profit, £102,184; brought forward, £12,388; preference dividend, 5 per cent. per annum, £11,261; ordinary dividend, 3s. per share, less tax, £66,448; welfare fund, £5,000; pension fund, £5,000; write off expenses of fusion with Muntz's Metal Company, Limited, £3,514; carry forward, £23,349.

Darwin, Yeardley & Company, Limited. — Capital £10,000 in £1 shares, to take over the business of ironfounders carried on by Laura Darwin, Fanny Darwin and Frank Darwin, as Darwin & Company, at Queen's Foundry, Queen Street, Sheffield. Directors: F. Darwin, E. Yeardley (chairman and managing director), D. Flather, and G. D. Flather.

Bolckow, Vaughan & Company, Limited. — Brought forward, £212,494; available, £576,471; debenture interest, preference dividend for year and interim ordinary dividend, £222,738; disposable balance, £353,735; final ordinary dividend, 4 per cent., less tax, making 8 per cent. for year; interest on debentures, £48,908; dividend on preference, £23,604; dividend on ordinary fully paid, 8 per cent. per annum, £211,128; ditto partly paid, £89,323; carried forward, £203,507.

Gazette.

TRADING under the style of Peter Ireland, Messrs. H. Ireland & J. W. Ireland, Victoria Road, Widnes, engineers, have dissolved partnership. Debts by J. W. Ireland, who continues the business.

NEWGATE FOUNDRY, LIMITED. — It was resolved August 17, confirmed September 1 :—That the company be wound up voluntarily. Mr. H. Wood, of Chipchase & Wood, Bishop Auckland, C.A., has been appointed liquidator.

THE COVENTRY SIMPLESS ENGINES, LIMITED, in liquidation.—Claims to Mr. E. N. Humphreys, Old Bank Buildings, Eastgate, Chester, C.A., or Mr. G. G. Poppleton, 26, Corporation Street, Birmingham, C.A., liquidators, by October 7.

TRADING under the style of the Burleigh Foundry Company, Messrs. A. E. Bayliss & A. Nicholls, 15 Burleigh Street, Walsall, malleable ironfounders, have dissolved partnership. Debts by Mr. A. Nicholls, who continues the business.

HOLLEY BROTHERS CARBURETTOR COMPANY, LIMITED, Birmingham.—It was resolved August 16, confirmed August 31 :—That the company be wound up voluntarily. Mr. H. C. Chambers, 6, Bennett's Hill, Birmingham, has been appointed liquidator. Claims to liquidator by October 15.

THE BILSTON IRON SHEET & GALVANIZING COMPANY, LIMITED.—Pursuant to section 188 of the Companies (Consolidation) Act, 1908, a meeting of creditors will be held at 19, Bedford Row, W.C., on September 23 at 3. Claims to Mr. D. F. E. Whitehouse, 121, Kingsway, W.C., liquidator, by October 14.

TRADING under the style of the Alliance Foundry Company, Messrs. R. M. Crawford, A. R. Bone, G. W. Bone, Jno. H. Flitton & A. Pratt, Icknield Road, Leagrave (Beds.), ironfounders, have dissolved partnership. Debts by Messrs. A. R. Bone, G. W. Bone, J. H. Flitton & A. Pratt, who continue the business.

XUM

Applications for Patents.

Marshall, A. S. Lathes, boring-machine, etc. 21,604. August 19.
Pickersgill, W. J. Conveying sheets, bars, etc. 21,622. August 15.
Pickersgill, W. J. Means for conveying metal sheets, bars, etc. 21,623. August 15.
Stein & Atkinson, Limited. Re-heating furnaces. 21,728. August 16. (France. June 16.)
American Abrasive Metals Company. Manufacture of metal castings. 22,516. August 24.
Bonn, C. R. H. Tube-bending machines. 22,646. August 26.
Bostelmann, F. O. and W. D., and La Rock, H. and J. Machine tool. 22,220. August 22.
Dunsmore, A. F. Centrifugal machines. 22,561. August 25.
Girouard, Sir E. P. C. Pulverising or disintegrating machines. 22,382. August 23.
Hannan, J. R., and Mills, C. H. Superheated steam. 22,705. August 26.
Klerner, H. Rock drills. 22,605. August 25. (Germany, January 21.)
Lambert, C. P. Dredger hoppers and hopper dredgers. 22,471. August 24.
Lane, J. B. Apparatus for manufacture of pipes, tubes, etc., from lead, etc. 22,260. August 22.
Lock-Nuts, Limited. Lock-nuts. 22,455. August 24.
Powdered Fuel Plant Company, Limited. Magnetic separators. 22,583. August 25.
Smithells, C. J. Manufacture of tungsten. 22,381. August 23.
Stehmann, H. Rotary calcining-furnaces. 22,705. August 26.
Underfeed Stoker Company, Limited, and Robey, E. W. Conveyers, etc. 22,491. August 24.
Vaughan, A. E. Mechanism for transmission of power. 22,327. August 23.
Verner, A. Process of covering aluminium with electrolytical deposit of nickel, cobalt, etc. 22,286. August 22.
A. C. Cutting & Welding Company, Limited, Flood, W. H., and Smout, D. T. Electrodes for electric welding, cutting, &c. August 31. 23,149.
Akhurst, W. A., and Allsopp, R. A. Jib cranes of the locomotive type. September 3. 23,502.
Bellis Heat Treating Company. Crucibles. August 30. (United States, August 30, 1920.) 23,035.
Burton, W. A. Treatment of metals. September 1. 23,280.
Ellis, R. E., and Gamlen, R. L. Foundry processes. August 31. 23,145.
Hall, S. Casting iron or steel ingots. September 1. 23,272.
Hargrove, J. Centrifugal pumps. September 2. 23,311, 23,312.
Heslington, J. Foundry core-making sand. August 29. 22,837.
Hybinette, N. V. Separating metals by electrolysis. August 29. 22,881.
Kirke, P. St. G. Water-tube boilers. September 1. 23,258.
Mowbray, E. G. B. de. Power transmission. September 2. 23,303.
Pickett, F. N. Process for recovery of copper and zinc from alloys. August 29. 22,877.
White, H. E. Machines for making expanded sheet-metal fabric. September 1. 23,251.
White, H. E. Metal-expanding machines. September 1. 23,252.
Davy Bros., Limited, and Crowe, E. Plate-rolling mills. September 10. 24,119.
Jones, M. L. Heat treatment of steel plates or bars for manufacture of tin and terne plates. September 8. 23,951.
Marine & Locomotive Superheaters, Limited. Superheaters for steam boilers. September 6. 23,742.
Metallbank und Metallurgische Ges. Process for continuous leaching of ores, metallurgical products, etc. September 10. 24,101.
Portham, R. S. Superheaters for steam-boilers. September 6. 23,742.
Quick, A. S. Method of treating ore. September 8. 23,952.

PASSENGER CAR UNDERFRAMES.—Tenders are invited by the Chinese Banking Group, on behalf of the Ministry of Communications, for 16 passenger car underframes for the Shanghai-Hangchow-Ningpo Railway. Regulations, drawings and specifications may be obtained from the office of the Chinese Banking Group upon payment of $30. Tenders will be opened at 2 p.m. August 31, 1921. As these drawings and specifications are fifty sets in all, each bidder is limited to one set only. The office of the Chinese Banking Group is located at the Peking Bankers' Association, Hsih Bee Shih, Chienmen, Peking.

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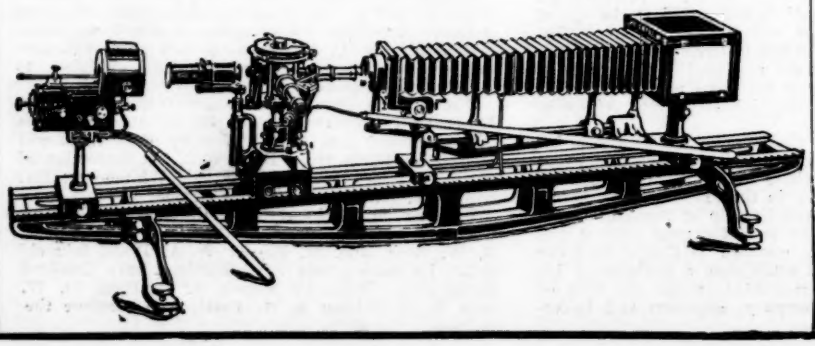

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